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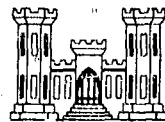
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MAY 1960

CRATERING FROM HIGH EXPLOSIVE CHARGES

CRATERING FROM HIGH EXPLOSIVE CHARGES COMPENDIUM OF CRATER DATA



TECHNICAL REPORT NO. 2-547

Report 1

May 1960



U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
Vicksburg, Mississippi

T. R. 2-547

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ARMY-MRC VICKSBURG, MISS.

PREFACE

This report is the first of two reports on the general subject, cratering from high explosive charges; it compiles in narrative and tabular form all available HE cratering data from test series in various media. The second report will analyze empirically the results reported herein. The study was conducted for the Office, Chief of Engineers, Department of the Army, as a part of Research and Development Subproject 8-12-95-420, "Nuclear Weapons Effects on Structures, Terrain, and Waterways" (Unclassified). It was accomplished during the period October 1957 through June 1959 by personnel of the Special Investigations Section, Hydraulics Division, U. S. Army Engineer Waterways Experiment Station, under the general supervision of Messrs. E. P. Fortson, Jr., and F. R. Brown. This report was prepared by SP-5 R. A. Sager, SP-4 C. W. Denzel, and Mr. W. B. Tiffany under the direct supervision of Messrs. G. L. Arbuthnot, Jr., and J. N. Strange.

The comments and suggestions of Cdr. W. T. Christensen, LCdr. B. S. Merrill, and Maj. E. H. Kleist as to the style and arrangement of the material are gratefully acknowledged.

Col. Edmund H. Lang, CE, was Director of the Waterways Experiment Station during the preparation of this report. Mr. J. B. Tiffany was Technical Director.

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NOTATIONS

d_a	Apparent crater depth, ft
d_t	True crater depth, ft
D_h	Horizontal diameter of camouflet, ft
D_v	Vertical diameter of camouflet, ft
h_a	Average crater lip height, ft
r_a	Average apparent crater radius, ft
r_r	Average radius of rupture of camouflet, ft
r_t	Average true crater radius, ft
V_a	Volume of apparent crater, cu ft
V_c	Volume of camouflet, cu ft
V_t	Volume of true crater, cu ft
W	TNT equivalent charge weight, lb
Z	Depth of burial of charge, ft
α_a	Average apparent crater angle, degrees (see fig. 2)
α_t	Average true crater angle, degrees (see fig. 2)
λ_c	Reduced charge position, $Z/W^{1/3}$, ft/lb ^{1/3}

SUMMARY

Any effort to perform an all-inclusive analysis of HE cratering experiments has, in the past, met with serious difficulties because of the intensive and laborious literature search necessary for the accumulation of pertinent data. This report was prepared in order to summarize all HE cratering data in a single report and thus facilitate future reference and correlation attempts. A second report will analyze the results presented herein.

The data compiled herein are presented in narrative and tabular form and have been grouped according to data obtained from cratering in soils (which includes clays, loess, silt, sand, etc.), frozen ground, rock, ice, and snow. Craters resulting from underwater shots are not considered in this report.

CRATERING FROM HIGH EXPLOSIVE CHARGES

COMPENDIUM OF CRATER DATA

PART I: INTRODUCTION

1. Any future application of large HE and nuclear explosions will doubtlessly involve near-surface or below-surface detonations which will produce craters of more or less conventional shape. The military applications of cratering are more or less obvious--e.g., to damage or destroy underground installations, to create barriers in various situations, etc.; however, the cratering process is now being studied in some detail for prospective civil applications to accomplish a variety of tasks. Whether the application be civil or military, it is certainly desirable to be able to predict with the greatest possible accuracy every phase of the cratering process, but particularly to be able to predict the size and shape of the crater formed.

2. In the past, any effort to analyze and correlate cratering data from HE explosions has met with considerable difficulty. Most of these data are presented in countless reports where they are treated as primary information or simply reported as incidental phenomena. By compiling and properly tabulating all of the HE cratering data under one cover, a substantial contribution will be made to future efforts at specific or comparative analyses.

3. Therefore, all pertinent HE cratering data, located during an exhaustive literature search, have been included in tables 1-6 of the main body of this report (covering crater and camouflet measurements in soil, and crater measurements in frozen ground, rock, ice, and snow) and table A1 of the appendix (giving additional crater measurements in soil). Every effort was made during the search to obtain every report published which contained cratering data; however, in an undertaking of this scope, it is recognized that some data were probably overlooked. Persons having access to cratering data not included in this report are requested to transmit these data in tabular form (similar to the format of tables 1-6) along with as detailed a description of the media as possible to: Director, U. S. Army

Engineer Waterways Experiment Station, CE, P. O. Box 631, Vicksburg, Mississippi, ATTN: Chief, Special Investigations Section. Additional data so received will be published as appendices to this report. A second report on this same general subject, namely, cratering from high explosive charges, will analyze empirically the results presented herein.

4. Cratering data from underwater shots have been purposely omitted.

PART II: THE LITERATURE SEARCH AND DATA TABULATION PROCEDURES

Literature

5. As stated in Part I, the Waterways Experiment Station (WES) has conducted, over a period of several years, an exhaustive literature search of all available reports, papers, and personal notes (some of which were, at the time received, unpublished) that contained cratering data. From this intensive survey, a bibliography has been prepared and is presented at the end of the narrative portion of this report.

6. The cratering data tabulated herein were extracted almost entirely from the formal reports listed in the bibliography; a small amount was obtained from shot records and personal notes describing various test results wherein cratering was a secondary measurement. A few of the reports listed in the bibliography did not contribute per se to the wealth of data tabulated; however, these particular reports were included since they supplement reports from which cratering data were extracted. For example, references 9-12 and 16 supplement the data from the Engineering Research Associates' (ERA) Underground Explosion test program, references 13-15. Similarly, three reports (33, 36, and 54) supplement the data from the Project Mole series, reference 32; one report (45) supplements the data obtained from the Panama Canal series, references 46-50; five reports (24, 25, 28, 30, and 31) include information that may assist in analyzing these data; four reports (3, 18, 29, and 34) present limited compendiums of cratering data; and two reports (26 and 27) include descriptions of the soil at several test sites from which cratering data were obtained.

Grouping of Data

7. Various crater measurements were obtained from more than 1800 shots. Arrangement of these data into similar or kindred groups was accomplished in order to assist users in attempts to analyze the data. Grouping of the data was accomplished by considering the following test parameters in the order named: type of media cratered, shape of charge, position of charge, and weight of charge.

4

Media grouping

8. Based upon the grouping procedure just described, the following tabulation shows the media groupings under which the data are tabulated:

<u>Table</u>	<u>Media</u>
1	Soil
2	Soil (camouflet measurements)
3	Frozen ground
4	Rock
5	Ice
6	Snow

Soil-type grouping

9. Crater and camouflet measurements in soils (tables 1 and 2, respectively) were subdivided into various soil types and further grouped to describe qualitatively the condition of the soil as to moisture content. The first of these groupings (soil types) was easily determined using accepted soil-classification procedures. The grouping according to moisture content was somewhat arbitrary. Where moisture-content data were available, the following criteria were established for classifying a given soil as wet, moist, or dry:

<u>Type Soil</u>	<u>Moisture Content, %</u>
Dry clay	0-12
Moist clay or loess	13-22
Wet clay or silt	>22
Dry-to-moist sand	0-3
Wet sand	>7

It is recognized that the assignment of numerical limits to the various conditions of wet, moist, and dry is highly dependent on grain size, organic content, etc.; however, the criteria given are believed to be acceptable as a "rule of thumb" for grouping the data into similar conditions of moisture content.

10. When moisture-content data were not available, the soil was placed in a given category based upon its general description contained in the particular report. Soils that could not be classed as wet, moist, or dry were grouped together and labeled "indefinite."

Grouping by charge shape

11. Among the shots included in the tabulations, many of the charges detonated were not spherically shaped. Because of this, it was necessary

to define arbitrarily when a given charge departed sufficiently from resembling a point source of energy to be considered a shaped charge. Perhaps the best way to define which charges are considered shaped and which unshaped is to describe the unshaped charge. To begin with, an unshaped charge exhibits blast effects as though they originated from a point source of energy. Accordingly, spherically shaped charges were considered unshaped. Also, charges that were cubically shaped or that were built up of smaller charges into a cube were considered to be unshaped. Likewise, cylindrical or rectangular charges (with square base) were not considered shaped charges provided the height-to-diameter (width of base) ratio was less than 1.5. All charges not falling within these restrictions were considered to be shaped or to propagate the explosive energy asymmetrically to an objectionable degree.

12. Grouping by charge shape was required only in table 1 as the data contained in tables 2-6 were obtained from shots involving unshaped charges exclusively. Cratering data derived from detonations of shaped charges are presented in sheets 19-24 of table 1.

Charge-position grouping

13. Order. Each shot from a given series of shots in a given medium was listed in order using the charge position as the governing criterion. Those placed highest aboveground were listed first, and those positioned deepest underground were listed last. This grouping was based on the reduced charge position, λ_c . In keeping with conventional practice, TNT was used as the base explosive; all other explosive types were converted to equivalent weights of TNT by using conversion factors, when such were available, as described in the following paragraphs.

14. Conversion of other explosives to TNT weights. The only available conversion factors for cratering were those developed by Lampson.^{21*} In a series of experimental tests, equal weights of TNT and some other explosive were detonated at identical charge positions. The craters were measured and the crater radii compared. As defined by Lampson,

$$\frac{r_X}{r_{TNT}} = \frac{E_X}{E_{TNT}} \left(\frac{W_X}{W_{TNT}} \right)^{1/3} \quad (1)$$

* Raised numbers refer to similarly numbered items in the Bibliography at end of text.

where

r_x = crater radius using explosive x , ft

r_{TNT} = crater radius using TNT, ft

E_x = explosive factor for explosive x , dimensionless

E_{TNT} = explosive factor for TNT, dimensionless

W_x = weight of explosive x , lb

W_{TNT} = weight of TNT, lb

Since TNT is used as the accepted base explosive, then $E_{TNT} = 1$ and

$$E_x = \frac{r_x}{r_{TNT}} \left(\frac{W_{TNT}}{W_x} \right)^{1/3}$$

To convert a given amount of explosive x to an equivalent weight of TNT, a specific weight of TNT must be found that will make

$$r_{TNT} = r_x, \text{ or } \frac{r_x}{r_{TNT}} = 1$$

Therefore, from equation 1,

$$1 = \frac{E_x}{E_{TNT}} \left(\frac{W_x}{W_{TNT}} \right)^{1/3}$$

Again, $E_{TNT} = 1$ and

$$E_x = \left(\frac{W_{TNT}}{W_x} \right)^{1/3}$$

or

$$W_{TNT} = E_x^3 W_x$$

Letting $E_x^3 = k$, the conversion equation becomes

$$W_{TNT} = k W_x \quad (2)$$

Note that k in equation 2 is equivalent to Lampson's E_x^3 .

15. The following conversion factors were derived by Lampson in reference 21.

<u>Explosive</u>	<u>Conversion Factor, k</u>
Amatol	0.94
Composition B	1.06
Dynamite (40% extra)	0.68
HBX-2	1.52
Minol	1.48
Pentolite	1.23
TNT	1.00
Tritonal	1.37

It should be noted that the above-listed factors are based on crater radius only and may be inappropriate for crater depth; however, since no other conversion system was available, the foregoing was used throughout this report to convert these types of explosives to equivalent weights of TNT. Conversion factors for these same explosives, based on the release of equal amounts of energy, are given in a paper by Cdr. Christensen.³

16. By means of the above-listed factors, equivalent weights of TNT were computed and used in determining the value of λ_c appropriate for the specified shot geometry. For those explosive types for which a conversion factor was not available, a value of λ_c was determined by using the actual weight of the explosive in conjunction with the particular depth of burial of charge. Although this procedure is only approximate, it does provide a means of placing the shot at or near its proper location within the respective tabulations.

Charge-weight grouping

17. When several shots were detonated at a common scaled depth of burial (λ_c remains constant), the shots were tabulated in the order of ascending weight of charge.

Table Nomenclature

18. The column headings for the six tables are generally the same, and the following descriptions are intended to clarify these headings.

Item Number provides a consecutive count of the total number of listings.

Source reveals the source of the data listed; the number refers to the corresponding number in the Bibliography.

Explosive Data describe the charge used as to type and weight of

explosive and, when possible, define the weight of TNT that is the equivalent in cratering potential to the particular explosive used.

Charge Position describes the actual position of the charge with respect to the ground-air interface and the reduced position of the charge based on TNT equivalent or nonequivalent weights as discussed in paragraphs 13-16.

Crater Dimensions:

Apparent. Columns under this heading list the apparent crater depth, radius, height of lip, angle of intersection, and volume.

True. The true crater depth, radius, angle of intersection, and volume are listed under this general heading.

Camouflet. Subheadings under this general heading define the vertical and horizontal diameters of the camouflet, the radius of rupture, and the camouflet volume.

PART III: CRATER DIMENSIONS

Methods of Measuring the Various Crater Dimensions

19. Various methods were used to determine the crater dimensions tabulated herein, particularly in sounding the true crater. The following paragraphs discuss these methods.

Routine survey method

20. This method adapts the simple level-surveying techniques to determine the profile of the apparent crater. This simply involves the determining of the change in elevation that occurs over an established crater diameter. Variations of this rudimentary technique are also used in determining the true crater limits.

Probe method

21. This is a method of establishing the limits of the true crater and is based on detecting a marked change in resistance to penetration by a probe. The probe is pushed through the fallback (see fig. 1) until the resistance to continued penetration increases sharply. This increase supposedly occurs at the boundary of the true crater which is defined simply as the crater that existed prior to any fallback. Measurements obtained using this method exhibit considerable scatter which is primarily due to the fact that the probe can penetrate into a fissure that is in reality a part of the complete rupture zone, thus distorting considerably the penetration that should have been observed. Because of the inaccuracies inherent in this method, its use has been abandoned.

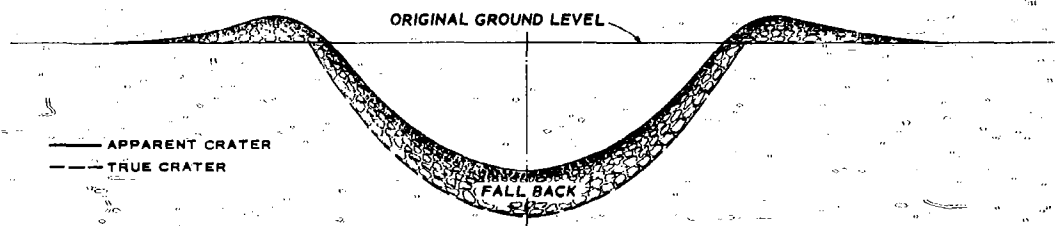


Fig. 1. Schematic crater section

Colored-column method

22. Along a line passing through ground zero, holes 2 to 4 in. in

diameter are drilled to depths roughly 25 per cent greater than the expected depth of the crater at any given range from surface zero. The holes are backfilled with a mixture of relatively fine sand, lime, and cement coloring in proportions that will provide density and strength properties very similar to the natural media. Immediately after the shot, a trench is excavated parallel to the line of holes but offset therefrom about 3 to 6 in. This 3- to 6-in. excess is then shaved away until the center of each colored column is exposed. The columns are then surveyed using the routine survey method described in paragraph 20. This colored-column method is very accurate for determining the limits of the true crater.

Hand excavation

23. In this method all loose material (fallback) is removed by hand and the "clean" crater is then surveyed. This method is appropriate for craters up to about 25 ft in diameter. Larger craters can normally be surveyed more easily using the colored-column method. The hand excavation method is just as accurate as the colored-column method, and is preferable in many instances, particularly for small craters.

Primary and Derived Crater Dimensions

Primary dimensions

24. Primary crater dimensions are those that are measured directly. Among these are: radius, depth, lip height, camoufllet diameter, and perhaps others that some agencies may have obtained. Definition of the more widely used crater dimensions are shown schematically in figs. 2 and 3.

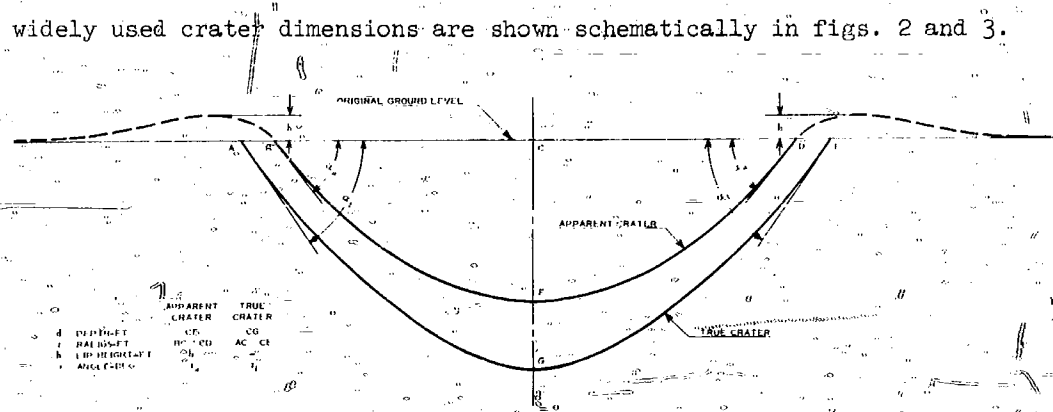


Fig. 2. Sketch defining crater nomenclature

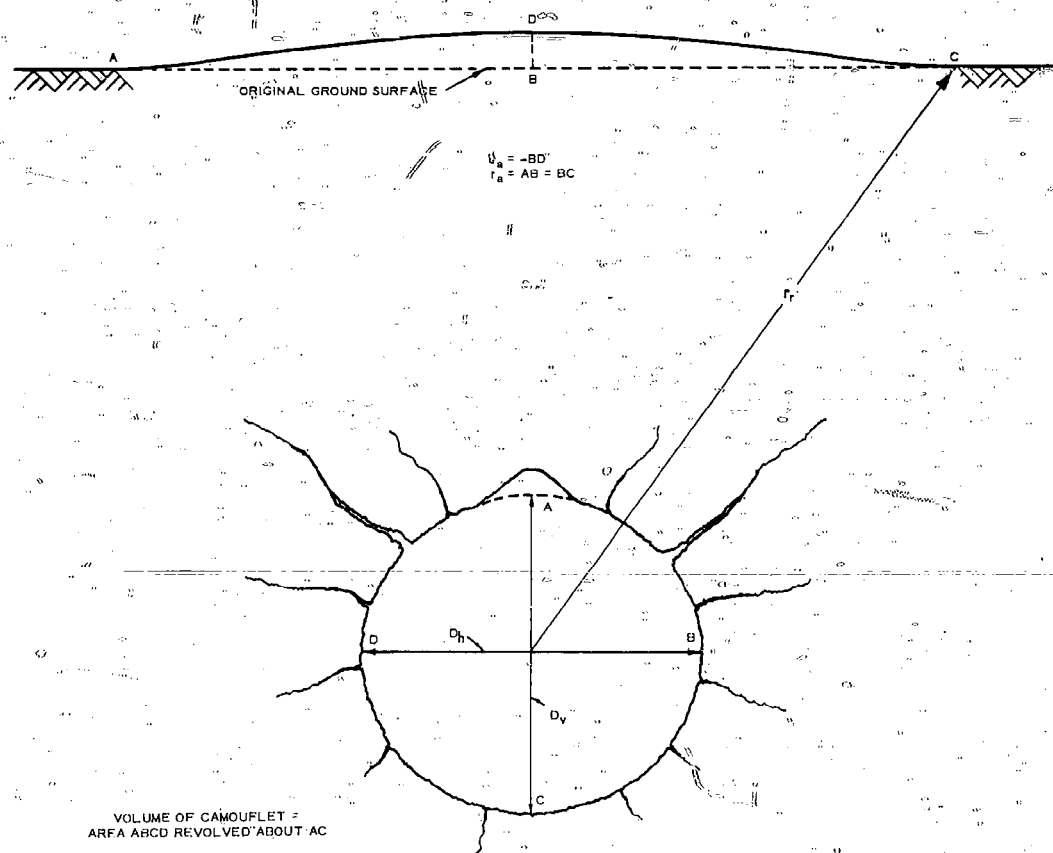


Fig. 3. Schematic diagram of typical camouflet and associated ground rise

25. The cratering data reported in reference 35 describe the crater radius as being the distance from ground zero to the maximum height of the crater lip. After a cursory study of crater shapes at various scaled depths of burial, it was concluded that these measurements could be made consistent with the definition shown in fig. 2 by multiplying the recorded radius by 0.8. Therefore, all values of crater radius extracted from reference 35 were reduced in this manner.

26. Some of the cratering data listed in reference 41 were influenced by an underlying rigid interface when the depth of overburden was less than a certain amount. For this reason, cratering data obtained from those shots influenced by the proximity of the interface were not included in the tabulations.

Derived dimensions

27. Derived crater dimensions are those that are computed. Among these are: area, volume, and sometimes the crater angle (see fig. 2). The crater volume was obtained by various agencies in several ways. Usually, however, it was computed by revolving the vertical, cross-sectional area of the crater through 180 degrees. In some instances, the average half-crater profile was used and revolved through 360 degrees. In isolated cases, the crater volume was determined by filling the void with some substance, noting the quantity used. Many of the references from which data were extracted did not describe the method used in computing the crater volume.

28. The crater angle (fig. 2) was determined from the average crater profile when it was provided. When profiles were not available, the depth, radius, and lip height were plotted on regular graph paper and an assumed profile of conventional shape was drawn through these plotted points. The appropriate crater angle was then measured from the profile as drawn.

PART IV: PROPERTIES OF THE VARIOUS MEDIA CRATERED

29. Since the size of a crater is also a function of the physical properties of the surrounding media, a general summary of these properties is presented for each of the test sites for which information on the media was available. Several of the test series reported soil properties for certain or all of the individual shots; however, the summary that follows is based on averages of the data provided.

Wet Clay

Dugway Proving Ground,
Utah (table 1, source 15)

30. The test site is located about 30 miles west of the proving ground proper.

"The material at the wet-clay site consisted of flat-lying, undisturbed layers of clay, the thickness of these layers ranging from 0.125 to 2 ft. Physically, the clay was quite homogeneous, the apparent layering being marked primarily by color variations. The deepest depth of clay recorded in a test drill hole was 62 ft. Below this depth, interbedded clays and sands probably occurred.

"Approximately vertical joints were quite numerous at the wet-clay site. In general, they were not so wide as those in the dry clay, but some were open enough to permit the flow of water. Most of the joints struck north-south, but some occurred which struck east-west.

"Seismic surveys, made by the Corps of Engineers, indicated that the seismic velocity was 2800 ft per second down to a depth of 3.5 ft; below this depth, the seismic velocity was 5600 ft per second. The 3.5-ft level probably corresponded to the water table."15

A summary of the Dugway test site soil data is presented in table 7.

Camp Cooke, California
(table 1, source 32)

31. Test shots 311, 312, and 313 of the Project Mole test series were detonated at this site which is located near the mouth of the Santa Ynez River where the ground surface was approximately 5.5 ft above the water table. The surface was hard silty clay underlain by moist sandy clay

to a depth of at least 22 ft. Table 7 summarizes the soil data for this site.

Clear Lake, Texas
(table 1, source 20)

32. The test program conducted at Clear Lake was accomplished as a part of the Underground Explosion test series. These detonations took place in Gulf Coast clay, which is more specifically typed as a sedimentary clay. Apparently the soil exploration for this site was limited to a seismic survey, which revealed a velocity of 1020 fps to a depth of 7.5 ft and a velocity of 5610 fps below this depth. This sudden increase in the seismic velocity seems to define the upper limits of the water table which fluctuate during different seasons of the year.

Panama Canal
(table 1, source 49)

33. All test shots detonated in marine muck during the Panama Canal test program were made in an area between the original canal and the south Miraflores approach channel to the Third Locks of the Panama Canal.

"The muck deposits are soft, very moist silts, clays, and organic deposits, which may be subdivided into four facies which intergrade laterally. These facies comprise gray to blue-gray silty clay; an organic black silt containing shells; black semi-decayed vegetable substances intermixed with silts; and light-gray or yellow-gray, weak plastic clay. This material was formed by deposition in swamps during Pleistocene time.

"The area used for testing is partially covered by 3 to 5 feet of old hydraulic fill of which the top one-foot is a crust of medium-hard, medium-plastic, cohesive, brown, loamy clay. This crust is softened by water that covers the area at high tide. Directly beneath the brown clay is a very soft, very highly plastic, gray clay that resembles soft soap or grease. This layer varies in thickness from 3 to 12 feet. Most of the shallow and medium depth charges were embedded in this soft mucky clay. Below this stratum is a layer of silty sand from 1 to 3 feet deep which is followed by mucky clay and silt which reaches a depth of 20 to 30 feet. The top of weathered rock varies from a depth of 26 to 36 feet."49

Moist Clay

WES clay pad (tables 1 and 2, sources 39, 42, 43)

34. Cratering tests in moist clay were conducted at the WES Big Black test site located approximately 10 miles southeast of Vicksburg, Mississippi. The shots were detonated in a 200- by 100- by 8-ft-deep built-up clay pad (see reference 42 for details of construction of pad). A qualitative description of the soil is presented in table 7.

Vicksburg clay (table 1, source 44)

35. All test shots in moist clay for the WES energy-partitioning test program were detonated near the WES Big Black test site in a natural clay area. Average results of Atterberg limits tests on the natural clay were as follows: the plasticity index varied with depth from 30 at 2 ft to 13 at 5 ft to 6 at 23 ft, and averaged 13. Additional data are given in table 7.

Panama Canal residual clay (table 1, source 50)

36. All test shots fired in residual clay during the Panama Canal test series were located in an area of the Panama Canal known as White's Island. The area is an undisturbed clay barrier (located in the Third Locks alignment) that had been cut down to the present elevation and maintained as a dam between Miraflores Lake and the Third Locks excavation channel. The material consists of a compact, slightly plastic, medium cohesive, red and gray clay that is very uniform in physical characteristics (see table 7).

London clay (table 1, source 1)

37. No detailed information on the soil was given for the tests reported as conducted in London clay. However, it was assumed that the clay in this region would be moist to wet.

Dry ClayDugway Proving Ground
(table 1, sources 15, 32)

38. Test shots 301 through 320 of the ERA Underground Explosion test program and test shots 101 through 111 of the Project Mole test program were conducted at Dugway Proving Ground, Dugway, Utah.

"The dry clay site was located at White Sage Flat, about 12.7 miles by road from the Dugway Proving Ground base camp. The site was investigated by the Corps of Engineers and its characteristics reported in detail...Great depths of lake sediments (fine unconsolidated material) were deposited there. Very thin sand lenses occurred and, below a depth of 20 feet, sand beds from one foot to ten feet thick were found. A white marl layer, whose thickness varied from hole to hole, was present. Many of the thin beds of the clays were discontinuous.

"The most important structural features of the dry clay site were two sets of vertical joints, one striking north-south and the other east-west. The north-south joints were more prominent, some of them being from one to two inches wide and filled with fairly loose clay. It was felt that the presence of these joints had a significant effect on the results obtained at the dry clay site.

"Fourteen seismic lines were shot at the dry clay site with velocities ranging from 1000 feet per second at a depth of 3.7 feet to 6150 feet per second at a depth of 93 feet. A velocity of 5400 feet per second was observed at the greatest depth measured, 138 feet.

"Ground water at the site was considered negligible, and it was believed that the water table lay at a depth of 300 feet or more. No water table was encountered in the exploratory drill holes, one of which extended to a depth of 163 feet. A zone of capillary saturation was reported in two of the drill holes at a depth of 136 feet."15

39. For the Project Mole test program the moisture content of the soil was estimated to be greater than it had been during the Underground Explosion test program. A summary of the soil data is presented in table 7.

Aberdeen Proving
Ground (table 1, source 17)

40. These tests were conducted in a very hard, dry clay, the density of which averaged about 90 lb per cu ft.

Naval Ordnance Laboratory (table 1, source 35)

41. All cratering shots during this test program were detonated in a heavy, rock-free clay. The location of the test site was not reported. Because of considerable weather variation, the moisture content of the clay varied over a wide range of values. Specific values of moisture content were not given.

Wet Sand

Aberdeen Proving Ground (table 1, source 6)

42. Test shots 1A16 through 5A42 of the Ballistics Research Laboratory (BRL) spherical charge test program were detonated at Sandy Point Beach, Aberdeen Proving Ground, Maryland. Apparently no detailed soil explorations were made at this site except for determination of the grain-size distribution. The grain-size analysis is as follows:

<u>U. S. Sieve Size</u>		<u>% of Total</u>
<u>No.</u>	<u>Opening, mm</u>	<u>Sample Passing</u>
10	2.0	98.1
20	0.84	94.9
40	0.42	46.2
60	0.25	11.9
140	0.105	0.2
200	0.074	0.0

In qualitative terminology, this sand would be considered medium to fine grained.

Dugway Proving Ground (table 1, source 15)

43. Test shots 101 through 116 of the ERA Underground Explosion test program were made at a site located about 5 miles east of the Dugway Proving Ground base camp. The test area consisted of sand dunes with the difference in elevation between trough and crest being about 20 ft. The sand depth was greater than 100 ft. Lenses of clay and thin beds of white marl were present near the surface, and at lower depths some gravel lenses were present.

44. Although the site was referred to as a dry sand site, the data

obtained in tests therein have been placed in table 1 along with the data from the wet sand shots. Reference 15 states that damp sand was encountered at a depth of a few inches. Frequent rain squalls during the firing program maintained the moisture at this depth; however, the water table was believed to be somewhat deeper than 170 ft. Considerable moisture was encountered in the lenses of clay and the rather deep layers of cemented sand and gravel.

45. Results of seismic explorations indicated the seismic velocity to be 800 to 1000 fps in the dune sands, and 1500 to 2000 fps in the water-lain sands below. Seismic values of 8000 to 9000 fps were encountered below 100 ft. More specific data on the Dugway test area sand are given in table 8.

Camp Cooke
(table 1, source 32)

46. Test shots 301 through 310 of the Project Mole test program were detonated near Camp Cooke, California.

"The test site is located on the banks of the lagoon formed at the mouth of the Santa Ynez River. This lagoon is blocked from the open sea by a sand bar and observations indicated that the water level did not vary measurably with daily tides or otherwise. The original ground surface at the test site was approximately 2 feet above water level and the soil consisted of silty sand mixed with organic matter for the first 2 feet, with saturated sand underlying the area. The test drilling showed that this sand was reasonably consistent to a depth of 20 feet where it was underlain by the so-called Monterey Shale. For the test series the original surface was removed by bulldozer in the vicinity of the shot points and blast lines so that the final surface was from 12 to 21 inches above the water table." 36

Other data on this material are presented in table 8.

WES interface study
(table 1, source 41)

47. Test shots 31 and 32 of the WES soil-rock interface study were detonated at the WES Big Black test site. Data from test shots where the soil-rock interface influenced the shape of the crater (shots 33 through 36) were omitted from this report (see paragraph 26). The soil-rock interface was formed by a massive concrete slab with an overlying layer of sand

The sand was "pit run" and was kept in a saturated state (see table 8).

Marshall Islands
(table 1, source 53)

48. In 1952, HE shots were fired on Elugelab Island, Eniwetok Atoll, in material that is defined as a water-saturated coral sand. Apparently no detailed soil explorations were made at this site.

Dry-to-Moist Sand

Yucca Flats
(table 1, sources 2, 7)

49. The HE test shots of Operation JANGLE were fired at Yucca Flats of the Nevada test site. For all practical purposes, the test area was flat. The soil was defined as extremely fine, powderlike sand mixed with some gravel. The seismic velocity was 3000 fps to a depth of 100 ft. A summary of other soil information is presented in table 8.

Aberdeen Proving Ground (table 1, source 6)

50. Test shots 501 through 1/4 C8 of the BRL spherical-charge test program were fired at Aberdeen Proving Ground in a large sand pit 48 in. deep. The average moisture content of the sand was 3.3 per cent. Apparently no further soil explorations were made at this site except for determination of the grain-size distribution; which was as follows:

U. S. Sieve Size No.	Opening, mm	% of Total Sample Passing
6	3.360	90.12
10	2.0	79.26
20	0.84	55.28
30	0.59	39.01
40	0.42	20.70
60	0.25	4.42
100	0.149	3.88
140	0.105	0.66
200	0.074	0.39

Qualitatively, this would be regarded as a coarse grade of sand.

Vicksburg dry sand
(table 1, source 40)

51. The dry-sand test series was conducted at the Big Black test

site in a rectangular pit approximately 10 by 10 by 2.5 ft. The sand was classified as being clean and well-graded. Care was taken to remold and recompact the sand after each shot to avoid appreciable density variations.

WES interface study
(table 1, source 41)

52. Test shots 1-21 of the WES soil-rock interface study were fired at the WES Big Black test site. Data from test shots where the soil-rock interface influenced the shape of the crater (shots 22-30) were omitted from table 1. The pit-run sand overlying the simulated soil-rock interface (see paragraph 47) had a density ranging from 97.6 to 109 lb per cu ft, and averaging 103 lb per cu ft. Moisture-content samples were taken at 0.5-, 1.5-, and 3.0-ft depths, and the average moisture contents for these respective depths were 4.4, 6.8, and 7.3 per cent. The over-all average moisture content was 6.6 per cent. Other soil data for this site are given in table 8.

Loess

Effects of Underground
Explosion tests, Natchez,
Mississippi (table 1, source 20)

53. All test shots detonated in loess during the Effects of Underground Explosions test program were fired at a site near Magnolia Bluff about 7 miles north of Natchez, Mississippi. Apparently no detailed soil explorations were made at this site except for seismic explorations. The moisture content of the soil, although not specifically reported, seemed to greatly affect seismic velocity; therefore, only the surface seismic velocity of 960 fps was considered accurate. The seismic velocity at lower depths varied considerably.

Vicksburg loess
(table 1, source 39)

54. These experimental tests were conducted in the northeast portion of the WES reservation. The loess in this area is very extensive and homogeneous. A quantitative description of the material is presented in table 9.

Various Soils

Vicksburg silt
(table 1, source 44)

55. Test shots 48-59 of the WES energy-partitioning test program were fired at the WES Big Black test site. The test area was about 100 by 200 ft. All shots were fired in undisturbed natural sandy silt soil. A summary of the soil data is presented in table 9.

Camp Gruber, Oklahoma
(table 1, source 5)

56. Several test shots were detonated in various soil types during the UET program, a portion of which was conducted at Camp Gruber. The test site is located in Muskogee County, Oklahoma, approximately 14 miles southeast of Muskogee and 60 miles southeast of Tulsa.

"The soils at the site are more or less heterogeneous and consist of all types of material ranging from fat silty clay to cohesionless clean sand. Water contents range from completely dry sand to saturated sandy silts and clays. In general, the more plastic materials are overlying the sandier materials...Geological investigations reported by the U. S. Geological Survey show that the tests were conducted in lacustrine terrace materials deposited during Pleistocene times. The bedrock consists of moderately dense sandstones and shales from the Winslow Formation of Pennsylvania Age."5

Princeton clay loam
(table 1, source 37)

57. During 1944, test shots to determine the effect of charge shape and orientation on craters in clay were detonated near the Ballistics Laboratory at Princeton University Station, Princeton, New Jersey. The soil was undisturbed, dry, hard, Sassafra clay loam. Apparently no detailed soil explorations were made at this site.

Frozen Ground

Keweenaw silt
(table 3, source 22)

58. All test shots in frozen Keweenaw silt were detonated in

northern Michigan. The test site, approximately 500 ft square, was free of stones and boulders and was uniform in composition. The silt was stratified with thin lenses of sand and organic deposits that were apparently not continuous. The soil classification showed the area to be predominantly silt and sandy silt. Plasticity tests indicated the soil to be, in general, nonplastic or of low plasticity. Preliminary exploration indicated that the silt layer was 7 ft deep. The moisture content of samples of the soil varied from approximately 30 per cent to slightly more than 100 per cent. A summary of the soil information from test shot 184 at this site is presented in table 9.

Fort Churchill till
(table 3; sources 23, 52)

59. Tests were conducted at sites located just south of the Churchill, Manitoba, airfield in 1955 and 1957. The test shots fired during the winter of 1955 were accomplished at two test sites, A and B, both in the same esker. Three explosive types, i.e. Composition C-3, Atlas 60, and Coalite 7-S (2- and 5-lb charges only), were detonated in the area designated as Blast Site A. At Blast Site B, 20-lb shots of Coalite 7-S were detonated.

60. Blast Site A consisted of a layer of gravel ranging from 6 to 10 in. in thickness, below which igneous and sedimentary boulders were dispersed at random in a matrix of unstratified frozen clay referred to as unstratified till. An average unit weight of 148.7 lb per cu ft was obtained from five large chunks of the unstratified till.

61. Blast Site B consisted of random layers of frozen vegetable matter over a 12- to 36-in. layer of frozen gravel with unstratified till below. The vegetable-matter layer, which contained ice lenses as much as 3 in. thick, had a maximum thickness of 12 in. The average weight of the frozen vegetable layer was 74.6 lb per cu ft. The average weight of the frozen gravel was 143.3 lb per cu ft.

62. The specific test site used during the 1957 test series is not described other than being at Fort Churchill.

Rock

Basalt, Panama Canal Zone (table 4, source 46)

63. Test shots 1-10 and 14 of the Panama Canal basalt test program were fired in the area known as Cerro Lirio Quarry. Test shots 11-13 were detonated in the area known as Paja Quarry. Test shots 15(1A) through 18(4A) were detonated in the area known as Fort Kobbe Quarry.

"The basalt is a dark gray, compact, very hard, fine-grained rock generally closely to moderately jointed and often showing columnar structure. It occurs in flows or as sills and dikes intruded into sedimentary rocks of early Miocene and older age. At Cerro Lirio Quarry it is a very hard, jointed basalt. Quarry blasting in the past apparently has superficially weakened the rock. The rock at Paja Quarry is one of the hardest basalts known in the vicinity of the Canal Zone. It is more closely jointed than the Basalt at Cerro Lirio and has a prominent columnar structure. The rock at the Fort Kobbe Quarry is a dark-gray to blue-black, very hard basalt, similar in abrasion resistance to the Paja Quarry rock. Joints are more widely spaced than average for Canal Zone basalts, and columnar structure is less prominent. Many of the joints contain a secondary filling of siliceous minerals, quartz and chalcedony."⁴⁶

Niobrara chalk, site of Fort Randall Dam (table 4, source 8)

64. All test shots in chalk during this U. S. Bureau of Mines test program were detonated at Fort Randall Dam site, Pickstown, South Dakota. A summary of the physical properties of the rock at this site is presented in table 10.

Unaweep granite, Grand Junction, Colorado (table 4, sources 4, 13)

65. All test shots in granite during the Colorado School of Mines (CSM) Underground Explosion test program and the ERA Underground Explosion test program were detonated in Unaweep Canyon, about 25 road miles south of Grand Junction, Colorado. Two types of granite occurred at the test sites, a fine- to coarse-grained light-gray granite and a very coarse-grained granite. The CSM test shots were accomplished in the fine- to coarse-grained light-gray granite. The ERA shots were detonated in both types. A summary

of the physical properties of the rock is presented in table 10.

Granite, Lithonia,
Georgia (table 4, source 8)

66. All test shots in granite during the U. S. Bureau of Mines test program were detonated at the granite quarry of Consolidated Quarries Corporation, Lithonia, Georgia. A summary of the physical properties of the rock is presented in table 10.

Limestone, Dugway Proving
Ground (table 4, source 13)

67. Both test shots in limestone during the ERA Underground Explosion test program were detonated at a site located about 10 miles east of Dugway Proving Ground. The limestone site was not considered to be particularly desirable; however, no better site was found in any area investigated. The limestone had several fault zones, the largest of which occurred in the upper beds. The beds in this area ranged in thickness from 0.5 to 6.5 ft. The depth to the water table is unknown. The limestone was quite dry; however, some moisture was nearly always present along erosion channels. The seismic velocity ranged from 7000 to 12,500 fps and averaged 11,000 fps.

Navajo sandstone, Castle Dale,
Utah (table 4, sources 4, 14)

68. All test shots in sandstone during the CSM and the ERA Underground Explosion test programs were detonated in the upper part of the Navajo sandstone near Castle Dale, Utah. The CSM test program was conducted about 23 miles east of Castle Dale, Utah, on the northwest flank of the San Rafael swell. The ERA test program was conducted about 16 miles east of Castle Dale, Utah, in Buckhorn Wash.

69. The primary structural feature of both test sites was the numerous sets of extensive joint systems. Both sites consisted of prominent joints striking and dipping in various directions. The exposed rock in the areas lose moisture due to evaporation; however, the unexposed rock maintain a small amount of moisture. Because of the wide variations in physical properties of the sandstone, specific values of these properties are not included in this report.

Green River marlstone, Rifle,
Colorado (table 4, source 8)

70. All test shots in marlstone in this U. S. Bureau of Mines test program were detonated at the Experimental Oil-Shale Mine, Bureau of Mines, Rifle, Colorado. A summary of the physical properties of the rock is presented in table 10.

Kanawha sandstone, Penn-
sylvania (table 4, source 8)

71. All test shots in sandstone in this U. S. Bureau of Mines test program were detonated at Seifer Farm and Eakin Quarry near Franklin, Pennsylvania. A summary of the physical properties of the rock is presented in table 10.

Culebra sandstone, Panama
Canal Zone (table 4, source 47)

72. The two test shots in Culebra sandstone during the Panama Canal test series were detonated on the west bank of the canal near stations 1750 and 1760. The test site was in the upper member of the Culebra formation. The formation is composed of beds and lenses of gray to buff, calcareous and tuffaceous sandstones, 3 to 10 ft in thickness. Apparently no additional rock information was obtained at the test site.

Gatun sandstone, Panama
Canal Zone (table 4, source 48)

73. All test shots in Gatun sandstone during the Panama Canal test series were detonated at the south plug of the Gatun Third Locks excavation.

"The Gatun formation is composed largely of argillaceous, variably calcareous, fine-grained sandstones interbedded with fine-textured volcanic tuffs and occasional thin conglomerate beds. Bedding in the formation is massive and remarkably uniform, with individual beds attaining thicknesses of 100 ft or more. The variably calcareous nature of the formation was conspicuous in the bed used for the crater tests, where numerous small masses of hard, well-cemented sandstone graded into the surrounding medium-hard slightly-cemented sandstone. The abundance of fossils show that this formation represents the produce of marine deposition of middle Miocene age." 48

Shale, Panama Canal
Zone (table 4, source 47)

74. All test shots in shale during the Panama Canal test series were detonated in the Cucaracha and Culebra formations on the west bank of the canal near stations 1750 and 1760.

"The Cucaracha formation consists of weak, locally bentonitic clay shales interbedded with fine, tuffaceous siltstones; medium- to coarse-grained, tuffaceous sandstones; pebble conglomerates; thinly bedded, black, carbonaceous, clayey shales; and a hard, gray agglomeratic tuff known as the 'ash flow.' The clay shales, which are predominant, consist of compact, medium hard, variably waxy or soapy, massively bedded, altered tuffs. A characteristic feature of the clay shale is the presence of irregular, smoothly-polished, minute fractures or slickensides. The color is mainly greenish gray, but some lenses within the clay shales are red brown to chocolate hues." 47

The two shots fired in the upper member of the Culebra formation were detonated in shale although the formation is composed mainly of sandstone.

Ice

Camp TUTO, Greenland
(table 5, source 51)

75. Cratering test shots were detonated in Greenland in 1957 at a site approximately 3 miles east of Camp TUTO. Camp TUTO is located approximately 12 miles east of Thule AFB. The depth of the ice was greater than 100 ft and its density averaged 55.6 lb per cu ft.

Snow

Alta, Utah
(table 6, source 19)

76. In 1956 the U. S. Snow Ice and Permafrost Research Establishment conducted tests near Alta, Utah, in a snow blanket 110 to 120 in. deep.

Camp Hale, Colorado
(table 6, source 38)

77. The three crater test shots of the 1958 WES snow test program

were fired at Camp Hale, Colorado. The snow was 4 ft deep, with the upper 1.5 ft composed of dry snow and the lower 2.5 ft composed of icy snow. The unit weights of the dry snow and the icy snow were 8 lb per cu ft and 12.2 lb per cu ft, respectively.

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Table 1
Results of Crater Measurements in Soil
(1 of 24 sheets)

ITEM NO.	SOURCE NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS									
		EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT					TRUE				
								d _c FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	r _t FT	α _t DEG	V _t CU FT		

* Numbers correspond to Bibliography numbers.

Table 1 (Continued)

ITEM NO.	SOURCE NO.	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ C	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT
					Shots Fired in Clay (Continued)												
Wet clay (Continued)																	
27	20	C-58	TNT	64	64	4.0	-4.2	-1.05									
28	20	C-59	TNT	64	64	4.0	-4.2	-1.05			9.0						
29	20	X-1	TNT	64	64	4.0	-4.2	-1.05			9.5						
30	20	X-5	TNT	64	64	4.0	-4.2	-1.05			10.7						
31	20	X-6	TNT	64	64	4.0	-4.2	-1.05			9.9						
32	20	X-7	TNT	64	64	4.0	-4.2	-1.05			11.9						
33	20	X-8	TNT	64	64	4.0	-4.2	-1.05			10.75						
34	20	X-9	TNT	64	64	4.0	-4.2	-1.05			10.3						
35	20	X-10	TNT	64	64	4.0	-4.2	-1.05			9.9						
36	15	401	TNT	8	8	2	-2.5	-1.25	5.0	7.0		47	32.0		10.0		
37	15	405	TNT	8	8	2	-2.5	-1.25	4.10	6.0		51	270		8.0		
38	49	2	TNT	8	8	2	-3.0	-1.50	5.10	6.60	0.98	41	257				
39	49	7	TNT	25	25	2.92	-4.5	-1.54	6.20	7.74	2.00	101	737				
40	20	B-19	TNT	64	64	4.0	-6.3	-1.58			11.0						
41	20	B-20	TNT	64	64	4.0	-6.3	-1.58			11.0						
42	20	C-34	TNT	64	64	4.0	-6.3	-1.58			10.0						
43	20	C-35	TNT	64	64	4.0	-6.3	-1.58	7.0	10.0		60	1,360	11.5	14.0	46	3,600
44	20	X-14	TNT	64	64	4.0	-6.3	-1.58			7.5						
45	20	X-15	TNT	64	64	4.0	-6.3	-1.58			7.75						
46	20	X-16	TNT	64	64	4.0	-6.3	-1.58			7.20						
47	20	X-17	TNT	64	64	4.0	-6.3	-1.58			8.00						
48	20	X-19	TNT	64	64	4.0	-6.3	-1.58			6.72						
49	40	X-20	TNT	64	64	4.0	-6.3	-1.58			7.80						
50	40	X-21	TNT	64	64	4.0	-6.3	-1.58			6.50						
51	20	X-22	TNT	64	64	4.0	-6.3	-1.58			5.20						

Table 1 (Continued)

(3 of 24 sheets)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	Yc	APPARENT								
									d _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	α _t DEG	V _t CU FT		
Met clay (Continued)												Shots Fired in Clay (Continued)					
52	20	X-23	TNT	64	64	4.0	-6.3	-1.58									
53	20	B-22	TNT	64	64	4.0	-6.4	-1.60		6.50							
54	20	A-1	TNT	64	64	4.0	-7.0	-1.75		10.32							
55	20	A-3	TNT	64	64	4.0	-7.5	-1.88		13.00							
56	49	8	TNT	25	25	2.92	-6.0	-2.05	6.05	6.51	2.50	74					
57	49	14	TNT	200	200	5.85	-12.0	-2.05	2.50	33.11	0.58						
58	20	A-2	TNT	64	64	4.0	-8.4	-2.10		12.50							
59	20	A-4	TNT	64	64	4.0	-8.4	-2.10		12.84							
60	20	A-5	TNT	64	64	4.0	-8.4	-2.10		14.16							
61	20	A-6	TNT	64	64	4.0	-8.4	-2.10		13.84							
62	20	A-7	TNT	64	64	4.0	-8.4	-2.10		12.00							
63	20	A-8	TNT	64	64	4.0	-8.4	-2.10		10.00							
64	20	A-9	TNT	64	64	4.0	-8.4	-2.10		12.00							
65	20	A-10	TNT	64	64	4.0	-8.4	-2.10		11.50							
66	20	A-24	TNT	64	64	4.0	-8.4	-2.10		12.00							
67	20	A-25	TNT	64	64	4.0	-8.4	-2.10		11.16							
68	20	B-15	TNT	64	64	4.0	-8.4	-2.10		11.50							
69	20	B-18	TNT	64	64	4.0	-8.4	-2.10		10.00							
70	20	B-27	TNT	64	64	4.0	-8.4	-2.10		10.50							
71	20	C-32	TNT	64	64	4.0	-8.4	-2.10		11.00							
72	20	C-33	TNT	64	64	4.0	-8.4	-2.10		12.64							
73	20	C-36	TNT	64	64	4.0	-8.4	-2.10		11.00							
74	20	C-37	TNT	64	64	4.0	-8.4	-2.10	5.80	12.50	64	900	14.3	14.25	51	3,800	
75	20	C-50	TNT	64	64	4.0	-8.4	-2.10		9.50							
76	20	C-51	TNT	64	64	4.0	-8.4	-2.10		11.00							
77	20	C-55	TNT	64	64	4.0	-8.4	-2.10		10.00							

Table 2 (Continued) (1 of 24 sheets)

ITEM NO.	SOURCE NUMBER	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS							
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W 1/3 LB 1/3	Z FT	λc	d _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	α _t DEG	V _t CU FT	
Wet clay (Continued)																
Shots Fired in Clay (Continued)																
78	20	C-57		64	64	4.0	-8.4	-2.10		9.50						
79	49	3		8.0	8.0	2.0	-5.0	-2.50	1.60	8.87	0.45	163				
80	49	9		25	25	2.92	-7.5	-2.57	3.00	10.96	0.98	446				
81	49	13		73	73	4.22	-12.0	-2.84	2.63	19.51	0.88	1,310				
82	20	C-29		64	64	4.0	-11.6	-2.90		10.50						
83	49	10		25	25	2.92	-9.0	-3.08	1.98	11.85	1.00	402				
84	20	B-14		64	64	4.0	-12.6	-3.15		10.00						
85	20	B-15		64	64	4.0	-12.6	-3.15		10.00						
86	20	B-17		64	64	4.0	-12.6	-3.15		8.50						
87	20	B-25		64	64	4.0	-12.6	-3.15		8.84						
88	20	C-28		64	64	4.0	-12.6	-3.15		8.00						
89	20	C-38		64	64	4.0	-12.6	-3.15		9.00						
90	20	C-32		64	64	4.0	-12.6	-3.15	3.10	9.50		470	16.4	12.0	42	3,400
91	20	C-52		64	64	4.0	-12.6	-3.15		9.50						
92	20	C-53		64	64	4.0	-12.6	-3.15		8.50						
93	20	C-54		64	64	4.0	-12.6	-3.15		8.00						
94	20	C-55		64	64	4.0	-12.6	-3.15		9.00						
95	49	4		8.0	8.0	2.0	-7.0	-3.50	3.14	4.52	1.55	138				
96	20	B-11		64	64	4.0	-4.3	-3.58		4.92						
97	49	11		25	25	2.92	-10.5	-3.60	2.93	11.27	1.51	291				
98	20	B-12		64	64	4.0	-16.8	-4.20		4.00						
99	20	B-13		64	64	4.0	-16.8	-4.20		4.44						
100	20	C-30		64	64	4.0	-16.8	-4.20		4.50						
101	20	C-31		64	64	4.0	-16.8	-4.20		5.60						

Table 1 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS										
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	A _C	APPARENT					TRUE					
									d _a FT	t _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	t _t FT	α _t DEG	V _t CU FT		
			Shots Fired in Clay (Continued)																
Moist clay																			
102	39	57	C-4	1.0	2.0	1.0	0.0	0.0	0.65	1.50	0.05	23	1.63	0.89	1.50	23	2.37		
103	50	6	TNT	25	25	2.92	0.0	0.0	2.10	3.80		29	32.9	2.50	4.49	44	57.8		
104	44	EL-31	Dynamite**	54	36.8	3.32	-1.5	-0.45	3.80	6.00	0.44	41	175	5.45	7.00	39	295		
105	44	EL-32	Dynamite†	54	36.8	3.32	-1.5	-0.45	3.60	6.00	0.43	38	170	5.35	6.50	35	256		
106	44	EL-34	Dynamite**	54	36.8	3.32	-1.5	-0.45	3.35	6.70	0.50	41	199	5.70	7.50	39	367		
107	44	EL-35	Dynamite†	54	36.8	3.32	-1.5	-0.45	4.35	6.60	0.55	38	224	5.37	7.50	35	333		
108	44	EL-36	Dynamite**	54	36.8	3.32	-1.5	-0.45	4.50	7.00	0.55	41	289	6.10	8.00	39	426		
109	44	EL-37	Dynamite†	54	36.8	3.32	-1.5	-0.45	4.00	6.50	0.65	38	224	5.30	7.00	35	304		
110	44	EL-38	Dynamite**	54	36.8	3.32	-1.5	-0.45	4.10	7.00	0.55	41	277	5.78	7.50	39	386		
111	44	EL-39	Dynamite†	54	36.8	3.32	-1.5	-0.45	4.10	6.45	0.58	38	214	5.60	6.50	35	290		
112	44	EL-40	Dynamite**	54	36.8	3.32	-1.5	-0.45	3.80	6.50	0.65	41	189	5.60	6.50	39	303		
113	44	EL-41	Dynamite†	54	36.8	3.32	-1.5	-0.45	3.60	6.10	0.45	38	162	4.90	6.50	35	255		
114	44	EL-47	Dynamite**	54	36.8	3.32	-1.5	-0.45	4.30	7.60	0.95	41	345	5.68	8.50	39	527		
115	44	EL-10	C-4**	27	27	3.00	-1.5	-0.50	4.50	6.65	0.50	38	262	5.40	6.65	27	345		
116	44	EL-11	C-4†	27	27	3.00	-1.5	-0.50	3.35	6.50	0.50	37	154	4.85	6.50	27	237		
117	44	EL-15	C-4**	27	27	3.00	-1.5	-0.50	4.45	6.40	0.38	38	227	5.50	7.00	27	347		
118	44	EL-16	C-4†	27	27	3.00	-1.5	-0.50	3.20	5.40	0.23	37	124	5.02	6.00	27	213		
119	44	EL-20	C-4**	27	27	3.00	-1.5	-0.50	4.00	6.80	0.43	38	213	5.55	7.50	27	344		
120	44	EL-21	C-4†	27	27	3.00	-1.5	-0.50	4.00	6.70	0.50	37	229						
121	44	EL-33	C-4**	27	27	3.00	-1.5	-0.50	4.25	6.10	0.54	38	196	5.40	6.50	27	278		
122	50	1	TNT	25	25	2.92	-1.5	-0.50	2.95	4.69		42	93.6	4.20	5.41	40	145		
123	43	A-1	C-4†	27	27	3.00	-2.25	-0.75	3.20	6.50	0.56	31	152	5.55	7.50	50	370		
124	43	A-2	C-4†	27	27	3.00	-2.25	-0.75	3.40	6.00	0.64	50	190	5.42	7.50	43	354		
125	43	A-3	C-4**	27	27	3.00	-2.25	-0.75	3.70	6.50	0.64	42	227	5.65	7.50	47	401		
126	43	A-4	C-4**	27	27	3.00	-2.25	-0.75	3.25	6.20	0.66	43	167	5.25	6.50	49	298		
127	42	S-22	Dynamite†	54	36.8	3.32	-3.00	-0.90	3.80	7.50	0.45	32	275	6.60	8.50	42	556		

† Unstamped.

** Stamped.

Table 1 (Continued) (6 of 24 sheets)

ITEM SOURCE NO.		SHOT NUMBER	EXPLOSIVE DATA			CHARGE POSITION		CRATER DIMENSIONS									
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	A ^c	d ₁ FT	h ₁ FT	C ₁ DEG	V ₁ CU FT	d ₂ FT	h ₂ FT	C ₂ DEG	V ₂ CU FT	
Moist clay (Continued)					Shots Fired in Clay (Continued)												
128	42	S-23	Dynamite†	54	36.8	3.32	-3.9	-0.90	4.00	7.50	0.56	27	285	6.55	8.00	43	510
129	42	S-24	Dynamite†	54	36.8	3.32	-3.0	-0.90	4.40	7.50	0.47	34	332	6.60	8.00	60	530
130	42	S-25	Dynamite††	54	36.8	3.32	-3.0	-0.90	4.90	8.50	0.59	48	458	6.70	9.00	55	731
131	42	S-26	Dynamite†††	54	36.8	3.32	-3.0	-0.90	4.90	8.50	0.71	42	455	6.90	9.00	52	731
132	42	S-27	Dynamite†††	54	36.8	3.32	-3.0	-0.90	5.00	7.50	0.48	35	403	6.70	8.50	84	693
133	42	S-28	Dynamite**	54	36.8	3.32	-3.0	-0.90	5.60	8.00	0.60	37	476	6.70	9.00	41	657
134	42	S-29	Dynamite**	54	36.8	3.32	-3.0	-0.90	5.10	8.50	0.48	39	481	6.90	9.00	47	706
135	39	S-6	C-4	1.0	1.0	1.00	-1.0	-1.0	1.30	2.30	0.16	27	3.39	2.05	2.30	45	1430
136	44	EL-8	C-4**	27	27	3.00	-3.0	-1.0	3.40	6.60	0.45	40	196				
137	44	EL-9	C-4†	27	27	3.00	-3.0	-1.0	3.00	6.15	0.55	33	127	6.50	6.50	32	332
138	44	EL-12	C-4†	27	27	3.00	-3.0	-1.0	2.75	6.0	0.45	30	114	5.95	6.0	23	259
139	44	EL-13	C-4**	27	27	3.00	-3.0	-1.0	4.40	6.75	0.45	40	276	6.40	7.50	37	446
140	44	EL-14	C-4†	27	27	3.00	-3.0	-1.0	3.35	6.00	0.25	33	150	6.12	7.00	32	289
141	44	EL-17	C-4†	27	27	3.00	-3.0	-1.0	2.95	5.80	0.28	30	118	6.24	6.00	23	264
142	44	EL-18	C-4**	27	27	3.00	-3.0	-1.0	4.33	7.30	0.70	40	282	7.10	7.50	37	464
143	44	EL-19	C-4†	27	27	3.00	-3.0	-1.0	3.45	6.15	0.32	33	174	6.40	7.00	32	330
144	44	EL-22	C-4†	27	27	3.00	-3.0	-1.0	3.30	6.00	0.65	30	146	6.30	7.00	23	318
145	44	EL-23	C-4**	27	27	3.00	-3.0	-1.0	3.90	6.70	0.55	40	250	6.65	7.00	37	373
146	44	EL-24	C-4†	27	27	3.00	-3.0	-1.0	2.20	5.30	0.48	33	80	6.00	6.00	32	230
147	42	S-8	C-4†	27	27	3.00	-3.0	-1.0	2.20	6.00	0.56	26	104	5.45	6.70	52	273
148	42	S-9	C-4†	27	27	3.00	-3.0	-1.0	2.75	5.80	0.50	33	128	5.65	6.85	43	254
149	42	S-10	C-4†	27	27	3.00	-3.0	-1.0	2.80	5.75	0.62	34	127	5.60	6.35	57	290
150	42	S-11	C-4††	27	27	3.00	-3.0	-1.0	3.20	6.70	0.70	27	186	6.25	8.00	61	491
151	42	S-12	C-4††	27	27	3.00	-3.0	-1.0	3.35	7.00	0.66	34	213	6.30	8.00	29	499
152	42	S-13	C-4††	27	27	3.00	-3.0	-1.0	2.80	6.60	0.69	31	169	6.20	7.35	49	349
153	42	S-14	C-4††	27	27	3.00	-3.0	-1.0	3.00	6.50	0.80	43	178	6.00	7.50	46	413

** Stamped.

† Unstamped.

†† 2/3 stamped.

Table 1 (Continued)

(7 of 24 sheets)

ITEM SOURCE NO.		SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λc	APPARENT								
									d _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	r _t FT	α _t DEG	V _t CU FT	
Moist clay (Continued)																	
154	42	S-15		27	27	3.00	-3.0	-1.0	3.10	6.50	0.63	32	182	6.25	7.50	56	409
155	42	S-16		27	27	3.00	-3.0	-1.0	3.40	6.75	0.58	31	181	6.30	7.15	50	392
156	42	S-17		27	27	3.00	-3.0	-1.0	3.90	7.00	0.42	30	234	6.00	8.00	48	486
157	42	S-18		27	27	3.00	-3.0	-1.0	4.70	7.00	0.50	34	298	6.20	7.50	56	459
158	42	S-19		27	27	3.00	-3.0	-1.0	4.00	6.90	0.50	32	223	6.20	7.50	58	450
159	42	S-20		27	27	3.00	-3.0	-1.0	4.10	7.00	0.58	40	249	6.10	7.50	75	402
160	42	S-21		27	27	3.00	-3.0	-1.0	4.00	6.50	0.66	41	230	6.10	7.00	48	379
161	50	5		200	200	5.85	-6.0	-1.03	9.43	16.94		44	3,550				
162	50	7		25	25	2.92	-4.5	-1.54	3.18	7.26		35	213	7.25	9.77	54	1,410
163	50	4		75	75	4.22	-8.0	-1.90	5.00	10.95		29	747				
164	39	58		1.0	1.0	1.00	-2.0	-2.00	-0.44	2.50	0.20	27		3.11	2.50	84	27.6
165	39	68		1.0	1.0	1.00	-2.25	-2.25	-0.18	4.50	0.32	18		3.26	3.00	47	35.6
166	39	69		1.0	1.0	1.00	-2.50	-2.50	-0.50	4.00		21		3.59	3.00	66	38.6
167	50	3		8.0	8.0	2.00	-5.0	-2.50	1.68	4.35		47	48.8	6.35	5.40	53	233
168	39	70		1.0	1.0	1.00	-2.75	-2.75	-0.85	3.50		25		3.73	2.80	62	33.4
169	50	2		75	75	4.22	-12.0	-2.84	1.95	12.32		22	374				
170	39	59		1.0	1.0	1.00	-3.00	-3.00	-1.54	3.50		32		4.05	2.50	35	19.5
171	39	60		1.0	1.0	1.00	-3.50	-3.50	-0.58	3.50		22		See Table 2 (Camouflets)			
172	50	8		8.0	8.0	2.00	-7.0	-3.50	2.50	3.51		62	56.1				
173	39	71		1.0	1.0	1.00	-3.90	-3.90									
174	39	61		1.0	1.0	1.00	-4.00	-4.00	-0.19	3.00		19		See Table 2 (Camouflets)			
175	39	72		1.0	1.0	1.00	-4.25	-4.25	-0.50	4.00		21		See Table 2 (Camouflets)			
176	39	62		1.0	1.0	1.00	-4.50	-4.50	-0.12	3.50				See Table 2 (Camouflets)			
177	39	73		1.0	1.0	1.00	-4.50	-4.50	-0.08	4.00				Crater not dug out			
178	39	63		1.0	1.0	1.00	-5.50	-5.50	-0.12	5.00				Crater not dug out			
179	39	64		1.0	1.0	1.00	-6.50	-6.50	-0.03	3.00							

** Stemmed.

2/3 stemmed.

1/3 veter stemmed.

\$ Above original ground surface.

Table 1 (Continued)

			EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ_c	d_a FT	r_a FT	h_a FT	α_a DEG	V_a CU FT	d_L FT	r_L FT	α_L DEG	V_L CU FT
					Shots Fired in Clay (Continued)												
Moist clay (Continued)																	
180	39	74	C-4	0.5	0.5	0.79	-5.56	-7.00	-0.01\$	3.50				See Table 2 (Camoufllets)			
181	39	65	C-4	1.0	1.0	1.00	-7.00	-7.00	-0.03\$	3.00				See Table 2 (Camoufllets)			
182	39	66	C-4	1.0	1.0	1.00	-7.50	-7.50	-0.01\$	2.50							
183	39	75	C-4	0.5	0.5	0.79	-6.35	-8.00									
184	39	67	C-4	1.0	1.0	1.00	-8.00	-8.00	-0.01\$	2.50							
185	39	76	C-4	0.5	0.5	0.79	-7.14	-9.00									
186	39	78	C-4	0.5	0.5	0.79	-7.94	-10.00	-0.01\$	2.50							
187	39	79	C-4	0.5	0.5	0.79	-8.33	-10.50									
188	39	80	C-4	0.5	0.5	0.79	-8.73	-11.00									
189	39	77	C-4	0.5	0.5	0.79	-9.13	-11.50	0.00					Crater not dug out			
190	39	81	C-4	0.5	0.5	0.79	-9.52	-12.00	0.00					See Table 2 (Camoufllets)			
Dry clay																	
191	15	301	TNT	320	320	6.84	+3.50	+0.51	1.00	2.50		34		1.00	2.50	34	
192	54	111	TNT	256	256	6.35	+1.65	+0.26									740
193	32	104	TNT	256	256	6.35	+0.83	+0.13	1.47	5.40	0.25	24	60.2				820
194	32	107	TNT	256	256	6.35	0.00	0.00	3.90	6.60	1.15	42	232.1				1,900
195	15	302	TNT	320	320	6.84	0.00	0.00	4.00	7.25		28	240	5.80	9.75	40	800
196	32	103	TNT	256	256	6.35	-0.83	-0.13					Partial detonation				
197	15	303	TNT	320	320	6.84	-1.30	-0.19	5.50	9.00		32	600	7.00	13.50	54	2,300
198	15	308	TNT	2,560	2,560	13.58	-2.60	-0.19	12.00	20.00		31	5,400	13.50	24.50	44	10,000
199	32	106	TNT	256	256	6.35	-1.65	-0.26	6.20	9.10	0.70	31	538.2				3,530
200	32	102	TNT	256	256	6.35	-3.18	-0.50	6.40	10.25	0.65	40	810.4				3,120
201	32	102A	TNT	256	256	6.35	-3.18	-0.50	5.35	9.60	0.95	37	588.2				4,570
202	15	316	TNT	110	110	4.79	-2.45	-0.51	6.00	9.00		38	740				
203	15	304	TNT	320	320	6.84	-3.50	-0.51	6.00	10.50		39	820	10.00	13.75	60	3,100
204	15	310	TNT	320	320	6.84	-3.50	-0.51	7.00	11.00		38	900	10.00	14.50	53	2,900

§ Above original ground surface

Table 1 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS										
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λc	APPARENT				TRUE						
									d _a FT	t _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	t _t FT	α _t DEG	V _t CU FT		
Dry clay (Continued)																			
205	15	313	TNT	320	320	6.84	-3.50	-0.51	8.00	12.75		36	1,500	9.50	15.25	41	3,000		
206	15	309	TNT	2,560	2,560	13.68	-7.00	-0.51	15.50	21.50		34	7,300	17.50	29.50	42	19,000		
207	15	312	TNT	2,560	2,560	13.68	-7.00	-0.51	15.00	26.00		31	13,000	18.00	30.50	46	25,000		
208	15	317	TNT	2,560	2,560	13.68	-7.00	-0.51	15.50	23.00		34	11,000	17.00	27.50		16,000		
209	15	319	TNT	2,560	2,560	13.68	-7.00	-0.51	13.50	23.00		34	7,800	17.00	25.00	68	15,000		
210	15	315	TNT	10,000	10,000	34.20	-17.5	-0.51	12.00	61.00		32	190,000	47.00	78.00		350,000		
211	15	318	TNT	320,000	320,000	68.40	-35.00	-0.51	60.00	120.00		44	1,100,000	77.00	130.00	46	1,800,000		
212	15	311	TNT	8	8	2	-2.00	-1.00	2.50	4.00		47	66	5.00	5.50	72	250		
213	32	101	TNT	256	256	6.35	-6.35	-1.00	5.40	10.55	1.25	37	742.4				1,230		
214	32	105	TNT	256	256	6.35	-6.35	-1.00	5.80	10.80	1.60	37	856.7				8,380		
215	15	305	TNT	320	320	6.84	-7.00	-1.02	7.00	11.75		58	1,300	11.50	16.50	51	4,600		
216	15	Symmetry	TNT	320	320	6.84	-7.00	-1.02	7.00	12.50		41	1,300	10.50	15.00	55	3,500		
217	15	314	TNT	8	8	2	-2.50	-1.25	3.00	3.0		41	86	4.70	6.50		230		
218	15	306	TNT	320	320	6.84	-14.00	-2.05	1.00	15.00		19	236	18.00	20.00	54	9,300		
219	15	307	TNT	320	320	6.84	-21.00	-3.07	1.00	10.00		20	100	26.50	15.50	55	5,400		
Indefinite clay §§																			
220	35		Pentolite	1.0	1.22	1.07	-0.37	+0.35	0.58	0.67		48							
221	35		Pentolite	1.0	1.22	1.07	+0.25	+0.23	0.79	0.83		51	Average data from two shots						
222	35		Pentolite	1.0	1.22	1.07	+0.12	+0.12	1.17	1.33		48	Average data from four shots						
223	35		Pentolite	1.0	1.22	1.07	0.00	0.00	1.33	1.74		44	Average data from three shots						
224	35		Pentolite	1.0	1.22	1.07	-0.12	-0.12	1.67	2.10		45	Average data from three shots						
225	35		Pentolite	1.0	1.22	1.07	-0.25	-0.23	2.37	2.40		52							
226	35		Pentolite	1.0	1.22	1.07	-0.38	-0.36	2.25	2.23		53	Average data from two shots						
Wet sand																			
Shots Fired in Sand																			
227	15	101	TNT	320	320	6.84	+3.50	+0.51	0.50	4.00		14		0.50	4.00				

§§ Moisture content and temperature of the clay varied over a wide range.

Table 1 (Continued)

ITEM SOURCE			EXPLOSIVE DATA			CHARGE POSITION		CRATER DIMENSIONS								
NO.	SHOT NUMBER	EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT
Met sand (Continued)																
Shots Fired in Sand (Continued)																
228	6	Pentolite	0.96	1.16	1.06	+0.41	+0.39	0.21	1.13		15					
229	6	Pentolite	0.96	1.16	1.06	+0.41	+0.39	0.11	1.35		13					
230	6	Pentolite	1.05	1.29	1.09	+0.42	+0.39	0.44	1.24		24					
231	32	TNT	256	256	6.35	+0.83	+0.13	1.46	4.05	0.50	36	37.4				450
232	32	TNT	256	256	6.35	+0.80	+0.13	4.70	8.90		47	447.2				
233	6	Pentolite	5.28	6.47	1.67	+0.23	+0.12	7.66	1.84		25					
234	53	C-2 and Tetraol	ff	2,000	12.60	+0.75	+0.06		27.50							
235	53	C-2 and Tetraol	ff	10,000	21.50	+1.30	+0.06		32.00							
236	53	C-2 and Tetraol	ff	20,000	27.10	+1.63	+0.06		37.50							
237	53	C-2 and Tetraol	ff	30,000	31.10	+1.87	+0.06		45.50							
238	53	C-2 and Tetraol	ff	40,000	34.20	+2.05	+0.06		50.00							
239	6	Pentolite	1.05	1.29	1.09	0.00	0.00	0.52	2.07		20					
240	41	C-4	27	27	3.00	0.00	0.00	2.40	4.40	0.53	30	54.3				
241	41	C-4	27	27	3.00	0.00	0.00	2.20	4.00	0.60	30	46.7				
242	32	TNT	256	256	6.35	0.00	0.00	1.70	6.35	0.80	37	129.3				575
243	32	TNT	256	256	6.35	0.00	0.00	4.70	12.90		47	1,317.2				
244	15	TNT	320	320	6.84	0.00	0.00	2.50	7.62	1.00	23	250		3.25	10.75	520
245	6	Pentolite	0.96	1.16	1.06	-0.12	-0.11	0.71	1.92		25					
246	6	Pentolite	0.96	1.16	1.06	-0.12	-0.11	0.69	1.90		24					
247	6	Pentolite	1.05	1.29	1.09	-0.12	-0.11	0.78	1.99		25					
248	6	Pentolite	5.34	6.54	1.67	-0.23	-0.12	1.35	3.12		27					
249	32	TNT	256	256	6.35	-0.83	-0.13	2.05	9.05	0.60	38	299.8				720
250	32	TNT	256	256	6.35	-0.80	-0.13	3.80	13.10		58	1,375.3				
251	32	TNT	256	256	6.35	-0.83	-0.13	3.40	8.30	1.00	33	293.3				
252	15	TNT	320	320	6.84	-1.30	-0.19	6.00	10.87	1.00	32	720		7.00	13.25	1,400
253	15	TNT	2,560	2,560	13.68	-2.60	-0.19	9.75	19.00		30	5,200		10.50	27.00	11,000

ff Only TNT equivalent weight given.

Table 1 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS											
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λc	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT			
						Shots Fired in Sand (Continued)														
Wet sand (Continued)																				
254	32	303	TNT	256		6.35	-1.60	-0.25												
255	32	305	TNT	256		6.35	-1.60	-0.25	6.30	16.10		48	2,070							
256	32	204	TNT	256		6.35	-1.65	-0.26	2.60	9.45	0.40	40	363.6				940			
257	32	405	TNT	256		6.35	-1.65	-0.26	4.55	9.80	0.80	35	198.2	4.60	9.30	37	626			
258	6	1A20	Pentolite	1.04		1.27	-0.49	-0.45	1.16	2.33		30								
259	6	1A22	Pentolite	1.05		1.29	-0.50	-0.46	1.22	2.44		30								
260	6	1A21	Pentolite	1.06		1.30	-0.50	-0.46	1.20	2.54		29								
261	32	203	TNT	256		6.35	-3.18	-0.50	3.95	8.35	0.95	43	355.6				920			
262	32	301	TNT	256		6.35	-3.17	-0.50	Sand and water repilly filled crater											
263	32	302	TNT	256		6.35	-3.17	-0.50	6.20	20.00	0.80	39	3,387.4							
264	32	309	TNT	256		6.35	-3.15	-0.50	6.10	16.70		40	2,718.4							
265	32	310	TNT	256		6.35	-3.15	-0.50	5.20	17.50		46	2,598.0							
266	32	401	TNT	256		6.35	-3.18	-0.50	5.50	10.60	0.60	26	824.4	6.30	11.30	38	1,182			
267	32	406	TNT	256		6.35	-3.17	-0.50	4.00	9.85	1.25	45	672.7							
268	15	101	TNT	320		6.84	-3.50	-0.51	6.50	12.00		32	1,300	7.50	15.50	30	2,600			
269	15	110	TNT	320		6.84	-3.50	-0.51	7.50	13.00		33	1,600	8.75	16.80	32	2,800			
270	15	113	TNT	320		6.84	-3.50	-0.51	6.75	14.00		29	1,900	7.50	17.50	27	3,800			
271	15	109	TNT	2,560		13.68	-7.00	-0.51	8.50	24.75		23	8,200	13.50	29.75	28	14,000			
272	15	112	TNT	2,560		13.68	-7.00	-0.51	12.50	30.00		26	13,000	17.50	34.00	31	25,000			
273	15	115	TNT	40,000		34.20	-17.50	-0.51	23.00	75.00		22	180,000	30.00	82.50	24	300,000			
274	32	305A	Dynamite	290		171.8	-3.17	-0.57	Data not reported											
275	32	301A	TNT	256		6.35	-4.77	-0.75	6.50	19.50		44								
276	32	402	TNT	256		6.35	-4.77	-0.75	6.20	11.05	1.45	35	942.7	8.20	12.50	39	1,687			
277	6	1A24	Pentolite	1.05		1.29	-1.01	-0.93	1.41	3.02		34								
278	6	1A23	Pentolite	0.96		1.18	-1.00	-0.94	1.76	2.89		35								
279	32	201	TNT	256		6.35	-6.35	-1.00	Partial detonation											

Detonated in shot number 303 crater (item 305).

Table 1 (Continued)

			EXPLOSIVE DATA				CHARGE POSITION		APPARENT						CRATER DIMENSIONS			
ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	A _c	d _a FT	r _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	r _t FT	α _t DEG	V _t CU FT	
Shots Fired in Sand (Continued)																		
Wet sand (Continued)																		
280	32	202	TNT	256	256	6.35	-6.35	-1.00	5.50	11.30	1.05	40	1,044.8					
281	32	212	TNT	256	256	6.35	-6.35	-1.00	5.85	11.70	1.60	43	1,206.9				2,630	
282	32	404	TNT	256	256	6.35	-6.35	-1.00	6.00	11.75	1.95	42	1,190.5	8.40	14.20	43	2,358	
283	15	105	TNT	320	320	6.84	-7.00	-1.02	8.50	15.50		32	2,600	12.50	18.50	37	4,400	
284	15	111	TNT	8	8	2	-2.50	-1.25	4.00	6.00		37	140	5.50	6.50	43	260	
285	15	114	TNT	8	8	2	-2.50	-1.25	3.50	6.00		33	150	6.50	7.50	44	510	
286	15	116	TNT	320	320	6.84	-8.75	-1.28	9.00	18.50		32	3,500					
287	15	106	TNT	320	320	6.84	-14.00	-2.05	4.50	16.75		20	1,100	17.00	19.50	45	6,200	
288	15	107	TNT	320	320	6.84	-21.00	-3.07	3.50	13.50		20	790	22.00	17.00	15	7,300	
Dry-to-moist sand																		
289	6	502	Pentolite	5.28	6.47	1.87	+1.29	+0.69	0.17	1.93	0.10		0.74					
290	6	501	Pentolite	5.29	6.48	1.87	+1.29	+0.69	0.17	1.97	0.10		0.85					
291	6	107	Pentolite	1.10	1.35	1.10	+0.75	+0.68	0.18	1.22	0.05		0.23					
292	6	108	Pentolite	1.07	1.31	1.10	+0.74	+0.67	0.12	1.50	0.05		0.37					
293	6	1/2 C2	Pentolite	0.55	0.67	0.83	+0.45	+0.51	0.72	1.40	0.11	24	1.42					
294	6	1019	Pentolite	0.96	1.18	1.06	+0.50	+0.47	0.07	1.11	0.05		0.15					
295	6	503	Pentolite	5.25	6.43	1.86	+0.87	+0.47	0.17	1.84	0.21		1.81					
296	6	504	Pentolite	5.27	6.46	1.86	+0.87	+0.47	0.17	1.94	0.23		0.74					
297	6	1/2 C7	Pentolite	0.55	0.67	0.88	+0.40	+0.45	0.26	1.31		17	0.30					
298	6	1010	Pentolite	1.09	1.34	1.10	+0.50	+0.45	0.12	1.07	0.05		0.17					
299	6	109	Pentolite	1.10	1.35	1.10	+0.49	+0.45	0.08	1.35	0.05		0.24					
300	6	1/4 C7	Pentolite	0.26	0.32	0.68	+0.30	+0.44	0.19	1.00		17	0.20					
301	6	1/4 C1	Pentolite	0.27	0.33	0.69	+0.30	+0.43	0.12	0.99			0.14					
302	40	689	TNT	4.0	4.0	1.59	+0.60	+0.40	0.20	1.83	0.02	14						
303	40	690	TNT	4.0	4.0	1.59	+0.60	+0.40	0.19	1.83	0.02	13						
304	40	691	TNT	4.0	4.0	1.59	+0.50	+0.30	0.26	1.75	0.04	15						

Table 1 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		APPARENT						CRATER DIMENSIONS			
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT	
Dry-to-moist sand (Continued)																		
305	40	692	TNT	4.0	4.0	1.59	+0.50	+0.30	0.22	1.72	0.05	14						
306	6	1011	Pentolite	1.10	1.35	1.10	+0.25	+0.23	0.18	1.19	0.11		0.34					
307	6	1012	Pentolite	1.10	1.35	1.10	+0.25	+0.23	0.25	1.05	0.15		0.38					
308	40	693	TNT	4.0	4.0	1.59	+0.30	+0.20	0.33	1.73	0.08	17						
309	40	694	TNT	4.0	4.0	1.59	+0.30	+0.20	0.32	1.87	0.07	16						
310	7	HE-4	TNT	2,560	2,560	13.68	+2.01	+0.15	1.90	6.10	2.80	23	110	2.10	8.00	4	180	
311	40	695	TNT	4.0	4.0	1.59	+0.20	+0.10	0.49	2.17	0.08	19						
312	40	696	TNT	4.0	4.0	1.59	+0.20	+0.10	0.57	2.14	0.10	20						
313	6	1/4 C2	Pentolite	0.26	0.32	0.68	0.00	0.00	0.53	1.34	0.10	25	1.27					
314	6	1024	Pentolite	0.96	1.18	1.06	0.00	0.00	0.61	1.67	0.12	23	2.15					
315	6	1025	Pentolite	0.97	1.19	1.06	0.00	0.00	0.76	1.76	0.20	27	3.44					
316	6	1014	Pentolite	0.98	1.20	1.06	0.00	0.00	0.68	1.68	0.16	28	3.31					
317	6	1013	Pentolite	1.10	1.35	1.10	0.00	0.00	0.49	1.50	0.16	25	2.28					
318	40	697	TNT	4.0	4.0	1.59	0.00	0.00	0.87	2.64	0.08	23						
319	40	698	TNT	4.0	4.0	1.59	0.00	0.00	0.81	2.53	0.15	22						
320	6	505	Pentolite	5.07	6.21	1.84	0.00	0.00	0.95	3.03		32	9.89					
321	41	1	C-4 (12.55)#	27	27	3.00	0.00	0.00	1.95	4.25	0.12	28	54.3	1.95	4.50	27	60.7	
322	41	2	C-4 (12.55)#	27	27	3.00	0.00	0.00	2.16	4.50	0.16	39	68.6	2.25	4.60	40	73.0	
323	41	10	C-4 (3.00)#	27	27	3.00	0.00	0.00	2.30	4.50	0.11	30	60.6	2.31	4.50	30	77.8	
324	41	11	C-4 (3.00)#	27	27	3.00	0.00	0.00	2.20	4.20	0.52	30	47.9	2.20	4.30	30	52.6	
325	41	18	C-4 (1.50)#	27	27	3.00	0.00	0.00	1.40##	4.50	0.53	39	63.9					
326	41	19	C-4 (1.50)#	27	27	3.00	0.00	0.00	1.30##	4.50	0.39	38	59.1					
327	41	3	Dynamite (12.55)#	54	36.8	3.32	0.00	0.00	2.20	5.00	0.46	28	81.8	2.24	5.15	30	89.3	
328	41	4	Dynamite (12.55)#	54	36.8	3.32	0.00	0.00	2.10	5.00	0.51	32	72.2	2.16	5.10	31	79.5	
329	41	12	Dynamite (3.00)#	54	36.8	3.32	0.00	0.00	2.30	4.65	0.57	34	68.7	2.36	4.67	34	83.7	
330	41	13	Dynamite (3.00)#	54	36.8	3.32	0.00	0.00	2.36	4.87	0.54	32	73.4	2.45	4.87	32	83.7	

Base slab exposed by shot.

Thickness of overburden (feet).

Table 1 (Continued)

ITEM SOURCE NUMBER			EXPLOSIVE DATA				CHARGE POSITION		APPARENT						CRATER DIMENSIONS				TRUE	
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ ^c	d _a FT	l _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	l _t FT	α _t DEG	V _t CU FT			
Dry-to-moist sand (Continued)																				
331	41	20	Dynamite (1.50)#	54	36.8	3.32	0.00	0.00	1.32	4.90	0.44	34	67.6	0.134	2.004		1.634			
332	41	21	Dynamite (1.50)#	54	36.8	3.32	0.00	0.00	1.42	5.20	0.46	48	93.7	0.104						
333	41	5	TNT (12.55)#	256	256	6.34	0.00	0.00	3.36	8.55	0.61	33	419	3.65	8.55	33	450			
334	41	6	TNT (12.55)#	256	256	6.34	0.00	0.00	3.50	8.60	0.80	31	391	3.55	8.60	31	412			
335	41	8	TNT (6.35)#	256	256	6.34	0.00	0.00	4.20	8.70	0.71	27	395							
336	41	9	TNT (6.35)#	256	256	6.34	0.00	0.00	4.40	9.25	0.82	28	539							
337	41	14	TNT (3.13)#	256	256	6.34	0.00	0.00	2.85##	9.00	0.87	35	448							
338	41	15	TNT (3.13)#	256	256	6.34	0.00	0.00	2.90##	9.60	0.94	38	531							
339	40	699	TNT	4.0	4.0	1.59	-0.21	-0.13	1.22	2.96	0.24	26								
340	40	700	TNT	4.0	4.0	1.59	-0.21	-0.13	1.20	3.10	0.24	25								
341	41	16	TNT (3.13)#	256	256	6.34	-0.85	-0.13	3.30	10.50	0.97	40	686	0.574	5.504	404	154			
342	41	17	TNT (3.13)#	256	256	6.34	-0.85	-0.13	3.42	12.00	0.95	42	1,040	0.524	6.504	424	194			
343	2	HE-9	TNT	216	216	6.00	-0.84	-0.14	3.50	8.30	0.70	24	270	4.00	14.70	6	1,120			
344	2	HE-9(A)	Pentolite	177	216	6.00	-0.84	-0.14	3.40	8.60	1.00	32	290	4.00	15.00	6	1,310			
345	7	HE-1	TNT	2,560	2,560	13.68	-2.01	-0.15	6.70	18.50	1.40	40	2,010	7.60	23.00	11	4,270			
346	7	HE-2	TNT	40,000	40,000	34.20	-4.63	-0.15	15.00	39.00	3.00	40	37,070							
347	2	HE-8	Pentolite	177	216	6.00	-1.08	-0.18	3.30	8.70	1.00	35	380	4.30	16.40	5	1,310			
348	2	HE-7	TNT	2,560	2,560	13.68	-2.50	-0.19	6.70	19.00	2.00	35	3,300	8.60	32.80	4	6,180			
349	2	HE-6	TNT	2,560	2,560	13.68	-3.00	-0.22	6.10	19.80	1.60	29	3,600	10.10	34.30	9	8,800			
350	6	IC17	Pentolite	0.97	1.19	1.06	-0.25	-0.24	1.00	2.25	0.22	30	7.51							
351	6	IC16	Pentolite	0.98	1.20	1.06	-0.25	-0.24	1.10	2.33	0.30	30	8.81							
352	40	701	TNT	4.0	4.0	1.59	-0.41	-0.26	1.40	3.42	0.26	26								
353	40	702	TNT	4.0	4.0	1.59	-0.41	-0.26	1.39	3.40	0.29	26								
354	2	HE-5	TNT	2,560	2,560	13.68	-4.00	-0.30	7.50	19.40	1.30	24	4,000	9.50	32.60	3	8,700			
355	6	1/4 C3	Pentolite	0.26	0.32	0.68	-0.29	-0.43	0.72	1.79	0.12	25	2.76							
356	6	1/2 C3	Pentolite	0.55	0.67	0.88	-0.40	-0.45	1.10	2.09	0.20	28	5.51							

Base slab exposed by shot.

Thickness of overburden (feet).

Crater dimensions of concrete slab.

Table 1 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS									
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT	
Dry-to-moist sand (Continued)																		
357	6	1/2 C14	Pentolite	0.56	0.59	0.88	-0.41	-0.47	1.12	2.26	0.19	30	7.59					
358	6	1C20	Pentolite	0.96	1.18	1.06	-0.50	-0.47	1.20	2.28	0.29	31	8.18					
359	6	1C13	Pentolite	0.97	1.19	1.06	-0.50	-0.47	1.27	2.57	0.20	32	12.04					
360	2	HE-10	TNT	216	216	6.00	-3.88	-0.50	5.50	11.30	0.80	40	860	6.30	18.60	9	2,600	
361	2	HE-10(2)	Pentolite	177	216	6.00	-3.00	-0.50	4.10	9.60	1.00	40	520	5.50	16.70	6	1,460	
362	7	HE-3	TNT	2,560	2,560	13.68	-6.79	-0.50	10.80	20.50	1.20	34	6,640	11.00	22.00	43	7,580	
363	6	1/4 C6	Pentolite	0.26	0.32	0.68	-0.95	-0.72	1.43	2.02	0.28	30	6.43					
364	6	1/2 C4	Pentolite	0.54	0.66	0.87	-0.80	-0.52	1.37	2.44	0.31	32						
365	6	1/4 C4	Pentolite	0.26	0.32	0.68	-0.63	-0.93	1.04	2.00	0.22	31	5.12					
366	6	1/2 C11	Pentolite	0.55	0.67	0.88	-0.82	-0.93	1.85	2.50	0.34	49	10.96					
367	6	1/2 C13	Pentolite	0.55	0.67	0.88	-0.82	-0.93	1.81	2.66	0.20	37	12.67					
368	6	1C21	Pentolite	0.96	1.18	1.06	-1.00	-0.94	1.41	2.87	0.24	35	15.28					
369	6	1/2 C10	Pentolite	0.55	0.67	0.88	-1.23	-1.40	2.19	2.76	0.17	60	15					
370	6	1/2 C12	Pentolite	0.55	0.67	0.88	-1.23	-1.40	1.87	2.71	0.34	38	14.28					
371	6	1C22	Pentolite	0.95	1.16	1.05	-1.49	-1.42	1.51	2.73	0.33	37	14.86					
372	6	1/4 C5	Pentolite	0.26	0.32	0.68	-1.20	-1.76	0.31	1.64	0.23		1.15					
373	6	1/2 C6	Pentolite	0.55	0.67	0.88	-1.59	-1.81	0.66	2.09	0.39		3.84					
374	6	1/2 C8	Pentolite	0.55	0.67	0.88	-1.64	-1.86	1.15	1.69	0.24	37	10.02					
375	6	1/2 C9	Pentolite	0.55	0.67	0.88	-1.64	-1.86	2.17	2.58	0.28	51	14.72					
376	6	1C23	Pentolite	0.96	1.18	1.06	-2.01	-1.90	0.41	2.41	0.30		2.81					
377	6	1/4 C5	Pentolite	0.26	0.32	0.68	-1.93	-2.84	0.50	1.84		20	2.19					
Shots Fired in Moist Loess																		
378	39	34	C-4	0.5	0.5	0.79	0.00	0.00	0.20	0.90	0.08	34	0.34	0.62	0.95	43	0.73	
379	39	39	C-4	0.5	0.5	0.79	0.00	0.00	0.28	1.10	0.04	22	0.73	0.75	1.12	25	1.18	
380	39	19	C-4	1.0	1.0	1.00	0.00	0.00	0.56	1.20	0.02	15	1.01	0.81	1.20	24	1.10	
381	39	25	C-4	1.0	1.0	1.00	0.00	0.00	0.53	1.25	0.10	23	0.95	0.79	1.40	32	1.46	

Table 1 (continued)

(16 of 24 sheets)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		APPARENT						CRATER DIMENSIONS						
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1.3} LB ^{1.3}	Z FT	λc	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT				
					Shots Fired in Moist Loess: (Continued)																
382	39	23	C-4	1.0	1.0	1.00	-0.50	-0.50	1.20	2.00	0.27	21	4.17	1.40	2.25	29	6.98				
383	39	27	C-4	1.0	1.0	1.00	-0.50	-0.50	0.98	2.00	0.10	20	3.93	1.47	2.00	45	6.41				
384	39	42	C-4	0.5	0.5	0.79	-0.50	-0.63	0.60	1.50	0.04	41	2.31	1.21	1.70	37	3.77				
385	39	52	C-4	0.5	0.5	0.79	-0.50	-0.63	0.35	2.00	0.07	30	3.41	1.33	2.00	48	6.40				
386	39	24	C-4	1.0	1.0	1.00	-1.00	-1.00	0.72	2.20	0.20	50	6.08	2.03	2.75	34	13.8				
387	39	26	C-4	1.0	1.0	1.00	-1.00	-1.00	0.65	2.25	0.15	28	5.84	2.07	2.25	45	11.4				
388	20	B-13	TNT	64	64	4.00	-4.20	-1.05		8.00											
389	20	B-14	TNT	64	64	4.00	-4.20	-1.05		10.00											
390	20	C-21	TNT	64	64	4.00	-4.20	-1.05		9.50											
391	20	C-22	TNT	64	64	4.00	-4.20	-1.05		8.00											
392	20	C-24	TNT	64	64	4.00	-4.20	-1.05		7.50											
393	20	C-26	TNT	64	64	4.00	-4.20	-1.05		6.24											
394	20	C-30	TNT	64	64	4.00	-4.20	-1.05		8.75											
395	39	35	C-4	0.5	0.5	0.79	-1.00	-1.26	0.31	2.00	0.10	22	2.70	1.73	2.00	27	5.89				
396	39	17	C-4	0.5	0.5	0.79	-1.00	-1.26	0.35	1.75	0.11	22	1.54	1.73	1.85	51	6.26				
397	39	22	C-4	1.0	1.0	1.00	-1.50	-1.50	0.33	3.20	0.09	17	3.54	2.49	3.00	41	19.6				
398	39	28	C-4	1.0	1.0	1.00	-1.50	-1.50	0.58	2.25	0.15	42	5.50	2.52	2.50	47	17.1				
399	20	B-15	TNT	64	64	4.00	-6.30	-1.58		9.75											
400	20	B-16	TNT	64	64	4.00	-6.30	-1.58		8.92											
401	39	50	C-4	0.5	0.5	0.79	-1.50	-1.89	-0.02	3.00				2.28	2.00	45	8.63				
402	39	54	C-4	0.5	0.5	0.79	-1.50	-1.89	0.70	1.50	0.09	40	2.38	2.23	1.50	66	6.81				
403	39	15	C-4	1.0	1.0	1.00	-2.00	-2.00	0.20	2.25	0.15	37	2.85	2.99	2.50	61	19.8				
404	39	21	C-4	1.0	1.0	1.00	-2.00	-2.00	0.13	2.60	0.11	12	2.22	3.02	2.75	46	20.3				
405	20	A-7	TNT	64	64	4.00	-8.40	-2.10		7.50											
406	20	B-12	TNT	64	64	4.00	-8.40	-2.10		9.50											
407	39	16	C-4	1.0	1.0	1.00	-2.50	-2.50	0.19	2.00	0.15	16	1.97	3.62	2.50	36	20.6				
408	39	17	C-4	1.0	1.0	1.00	-2.50	-2.50	0.40	1.35	0.15	28	1.12	3.52	3.00	41	25.7				

§ Above original ground surface.

Table 1 (Continued)

ITEM NO.	SOURCE NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS					TRUE				
		EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT					TRUE				
								d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT	
				Shots Fired in Moist Loess (Continued)													
409	39 36	C-4	0.5	0.5	0.79	-2.00	-2.52	-0.30	2.50		20	3.11	2.78	1.75		11.1	
410	39 40	C-4	0.5	0.5	0.79	-2.00	-2.52	-0.07	3.25		3		2.76	1.75	62	8.36	
411	39 53	C-4	0.5	0.5	0.79	-2.00	-2.52	-0.12	3.00		8		2.74	1.50	54	7.4	
412	39 44	C-4	0.5	0.5	0.79	-2.18	-2.74	-0.67	3.00		29		See Table 2 (Camouflets)				
413	39 48	C-4	0.5	0.5	0.79	-2.18	-2.74	0.07	3.00		30		2.96	1.50	82	8.81	
414	39 51	C-4	0.5	0.5	0.79	-2.18	-2.74	0.02	2.75				2.99	1.50	67	8.03	
415	39 2944	C-4	1.0	1.0	1.00	-2.75	-2.75	-0.04	5.00				3.79	3.00	33	28.5	
416	39 3144	C-4	1.0	1.0	1.00	-2.75	-2.75	-0.31	5.00		11		3.95	2.50	37	18.0	
417	39 33	C-4	1.0	1.0	1.00	-2.75	-2.75	-0.31	4.50		13		3.75	2.50		21.0	
418	39 1244	C-4	1.0	1.0	1.00	-3.00	-3.00	-0.55	4.00		21		4.06	2.50	65	22.3	
419	39 1544	C-4	1.0	1.0	1.00	-3.00	-3.00	-0.70	5.00		22		4.10	2.75	48	25.6	
420	39 43	C-4	0.5	0.5	0.79	-2.50	-3.15	-0.28	3.25		16		See Table 2 (Camouflets)				
421	39 49	C-4	0.5	0.5	0.79	-2.50	-3.15	-0.51	3.00		25		See Table 2 (Camouflets)				
422	39 30	C-4	1.0	1.0	1.00	-3.25	-3.25	-0.48	4.50		18		See Table 2 (Camouflets)				
423	39 32	C-4	1.0	1.0	1.00	-3.25	-3.25	-0.55	4.50		20		See Table 2 (Camouflets)				
424	39 9	C-4	1.0	1.0	1.00	-3.50	-3.50	-0.84	4.00		28		See Table 2 (Camouflets)				
425	39 10	C-4	1.0	1.0	1.00	-3.75	-3.75	-0.63	4.00		24		See Table 2 (Camouflets)				
426	39 14	C-4	1.0	1.0	1.00	-3.75	-3.75	-0.45	5.00		16		See Table 2 (Camouflets)				
427	39 37	C-4	0.5	0.5	0.79	-3.00	-3.78	-0.36	3.00		20		See Table 2 (Camouflets)				
428	39 55	C-4	0.5	0.5	0.79	-3.00	-3.78	-0.26	3.00		16		See Table 2 (Camouflets)				
429	39 41	C-4	0.5	0.5	0.79	-3.10	-3.90	-0.26	2.75		16		See Table 2 (Camouflets)				
430	39 45	C-4	0.5	0.5	0.79	-3.10	-3.90	-0.17	3.25		9		See Table 2 (Camouflets)				
431	39 11	C-4	1.0	1.0	1.00	-4.00	-4.00	-0.30	4.00		12		See Table 2 (Camouflets)				
432	39 13	C-4	1.0	1.0	1.00	-4.00	-4.00	-0.31	4.50		12		See Table 2 (Camouflets)				
433	39 20	C-4	1.0	1.0	1.00	-4.00	-4.00	-0.31	2.25		22		See Table 2 (Camouflets)				
434	39 38	C-4	0.5	0.5	0.79	-3.25	-4.10	-0.30	3.00		17		See Table 2 (Camouflets)				
435	39 46	C-4	0.5	0.5	0.79	-3.25	-4.10	-0.27	3.00		16		See Table 2 (Camouflets)				

44 Partial canouflet.

§ Above original ground surface.

Table 1 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT						TRUE		
									d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT
					Shots Fired in Moist Loess (Continued)												
436	39	84	C-4	0.125	0.125	0.50	-2.50	-5.00						See Table 2		(Camoufllets)	
437	39	95	C-4	0.125	0.125	0.50	-2.50	-5.00						See Table 2		(Camoufllets)	
438	39	82	C-4	8.0	8.0	2.00	-10.00	-5.00						See Table 2		(Camoufllets)	
439	39	83	C-4	8.0	8.0	2.00	-10.00	-5.00						See Table 2		(Camoufllets)	
440	39	1	C-4	1.0	1.0	1.00	-6.00	-6.00	-0.025	3.00				See Table 2		(Camoufllets)	
441	39	2	C-4	1.0	1.0	1.00	-6.00	-6.00	-0.055	4.00				See Table 2		(Camoufllets)	
442	39	7	C-4	1.0	1.0	1.00	-6.00	-6.00	-0.045	4.00				See Table 2		(Camoufllets)	
443	39	3	C-4	1.0	1.0	1.00	-8.00	-8.00	-0.015	4.50				See Table 2		(Camoufllets)	
444	39	4	C-4	1.0	1.0	1.00	-8.00	-8.00	-0.025	4.00				See Table 2		(Camoufllets)	
445	39	5	C-4	1.0	1.0	1.00	-10.00	-10.00	-0.015	3.50				See Table 2		(Camoufllets)	
446	39	6	C-4	1.0	1.0	1.00	-10.00	-10.00						See Table 2		(Camoufllets)	
447	39	8	C-4	1.0	1.0	1.00	-14.00	-14.00	0.00					See Table 2		(Camoufllets)	
					Shots Fired in Wet Silt												
448	44	E1-51	C-4	27	27	3.00	+1.85	+0.62	0.40	3.00		5	4.17				
449	44	E1-52	C-4	27	27	3.00	+1.85	+0.62	0.27	2.85		5	2.46				
450	44	E1-53	C-4	27	27	3.00	+1.85	+0.62	0.30	3.50		5	5.08				
451	44	E1-48	Dynamitet	54	36.8	3.32	-1.50	-0.45	3.60	7.20	0.80	36	280	5.00	7.50	54	361
452	44	E1-49	Dynamite**	54	36.8	3.32	-1.50	-0.45	4.50	8.00	1.00	37	452	5.20	8.50	29	548
453	44	E1-50	Dynamite**	54	36.8	3.32	-1.50	-0.45	5.30	8.30	1.05	37	504	5.30	9.00	29	634
454	44	E1-58	Dynamitet	54	36.8	3.32	-1.50	-0.45	3.70	6.35	0.62	36	177	4.70	7.00	54	362
455	44	E1-59	Dynamite†	54	36.8	3.32	-1.50	-0.45	3.60	6.75	0.50	36	223	4.80	7.50	54	422
456	44	E1-54	C-4**	27	27	3.00	-1.50	-0.50	4.20	7.50	1.00	33	362	4.80	8.50	31	528
457	44	E1-55	C-4†	27	27	3.00	-1.50	-0.50	3.68	6.50	0.80	41	220	5.00	7.00	33	336
458	44	E1-56	C-4†	27	27	3.00	-1.50	-0.50	4.00	7.00	0.68	41	264	5.18	8.00	33	404
459	44	E1-57	C-4**	27	27	3.00	-1.50	-0.50	5.30	8.25	0.75	33	437	5.50	9.00	31	568

** Stemmed.

† Unstemmed.

§ Above original ground surface.

Table 1 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS						
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ_c	d_a FT	h_a FT	α_a DEG	V_a CU FT	d_t FT	α_t DEG	V_t CU FT
						Shots Fired	with Shaped Charges								
CLAY															
460	1	19	TNT ^B	128(53.8)†	128	5.04	+1.80	+0.36	2.90	2.88	53				
461	1	20	TNT ^B	128(53.8)†	128	5.04	+1.80	+0.36	3.10	3.50	49				
462	1	21	TNT ^B	128(53.8)†	128	5.04	+1.80	+0.36	2.10	3.75	37				
463	1	22	TNT ^B	128(53.8)†	128	5.04	+1.80	+0.36	3.10	3.50	49				
464	1	27	Anstol ^B	242(50)†	242††	6.23	+2.23	+0.36	3.50	6.35	36				
465	1	28	Anstol ^B	242(50)†	242††	6.23	+2.23	+0.36	5.00	7.50	41				
466	1	29	Anstol ^B	242(50)†	242††	6.23	+2.23	+0.36	4.50	6.75	41				
467	1	30	Anstol ^B	242(50)†	242††	6.23	+2.23	+0.36	2.66	6.75	31				
468	1	31	Anstol ^B	242(50)†	242††	6.23	+2.23	+0.36	2.66	6.75	31				
469	1	32	TNT ^B	1,496(75)†	1,496	11.44	+3.90	+0.34	4.50	6.37	42				
470	1	33	TNT ^B	1,496(75)†	1,496	11.44	+3.90	+0.34	3.75	5.50	41				
471	1	34	TNT ^B	1,496(75)†	1,496	11.44	+3.90	+0.34	4.10	6.00	41				
472	1	35	Anstol ^B	1,496(75)†	1,496††	11.44	+3.75	+0.33	3.66	5.00	43				
473	1	36	Anstol ^B	1,496(75)†	1,496††	11.44	+3.25	+0.28	4.00	6.25	40				
474	1	37	Anstol ^B	2,790(70)†	2,790††	14.08	+3.40	+0.24	7.33	11.75	39				
475	1	44	PAG	300			+1.50		4.31	6.66	40				
476	1	45	PAG	300			+1.50		4.17	7.50	37				
477	1	7	TNT ^G	51.8(47)†	51.8	3.73	-1.00	-0.27	4.75	8.25	38				
478	1	6	TNT ^G	51.8(47)†	51.8	3.73	-2.50	-0.67	5.66	9.25	39				
479	1	11	TNT ^G	275.6(50)†	275.6	6.51	-8.00	-1.23	9.00	16.88	36				
480	1	9	TNT ^G	275.6(50)†	275.6	6.51	-9.50	-1.46	9.00	17.50	35				
481	1	18	Anstol ^B	85.44(48)†	85.44††	4.40	-7.50	-1.70	4.75	9.62	35				
482	1	24	TNT ^B	128(53.8)†	128	5.04	-9.50	-1.88	8.00	15.00	36				
483	1	8	Anstol ^G	275.6(50)†	275.6††	6.51	-12.50	-1.92	8.50	18.25	33				
484	1	10	TNT ^G	275.6(50)†	275.6	6.51	-12.50	-1.92	9.00	18.75	34				
485	1	12	TNT ^G	275.6(50)†	275.6	6.51	-12.50	-1.92	10.00	17.50	37				

Note: ^B indicates British Bomb; ^G indicates German Bomb. † Per cent of charge weight to total bomb weight. †† Anstol and TNT are considered equal.

Note: B indicates British Bomb; G indicates German Bomb.

† Per cent of charge weight to total bomb weight.

†† Anstol and TNT are considered equal.

Per cent of charge weight to total bomb weight.
100
90
80
70
60
50
40
30
20
10
0

Note: E indicates British Bomb; G indicates German Bomb.

Table 1 (Continued)

ITEM NO.			SHOT SOURCE NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS							
				EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT				TRUE			
Shots Fired with Shaped Charges (Continued)																	
Dry clay (Continued)																	
511	17	15	TNT	8.0	8.0	2.00	-3.00	-1.50	2.00	6.00				3.67	5.50		
512	17	7	TNT	1.0	1.0	1.00	-1.60	-1.60	0.67	2.58				2.75	2.58		
513	17	6	TNT	1.0	1.0	1.00	-2.00	-2.00	0.50	2.50				3.00	2.75		
514	17	14	TNT	1.0	1.0	1.00	-2.00	-2.00	0.33	2.62				3.58	2.75		
515	17	2	TNT	1.0	1.0	1.00	-2.50	-2.50	0.25	2.50							
516	17	4	TNT	1.0	1.0	1.00	-2.50	-2.50	0.83	1.50				4.50	2.25		
517	17	12	TNT	1.0	1.0	1.00	-2.50	-2.50	0.17	1.75				3.33	1.62		
518	17	9	TNT	1.0	1.0	1.00	-3.50	-3.50						4.00	1.62		
519	17	11	TNT	1.0	1.0	1.00	-3.50	-3.50						4.50	1.50		
Undisturbed, dry, hard Sassafraz clay loam																	
520	37	A-1	TNT	1.0	1.0	1.00	0.00	0.00						0.67	0.92		
521	37	B-1	TNT	1.0	1.0	1.00	0.00	0.00						0.50	1.16		
522	37	C-1	TNT	1.0	1.0	1.00	0.00	0.00						0.50	1.00		
523	37	A-2	TNT	1.0	1.0	1.00	-2.00	-2.00						3.00	2.83		
524	37	B-2	TNT	1.0	1.0	1.00	-2.00	-2.00						3.17	3.25		
525	37	C-2	TNT	1.0	1.0	1.00	-2.00	-2.00						3.33	3.00		
526	37	A-3	TNT	1.0	1.0	1.00	-3.50	-3.50						4.50	2.71		
527	37	B-3	TNT	1.0	1.0	1.00	-3.50	-3.50						4.75	2.75		
528	37	C-3	TNT	1.0	1.0	1.00	-3.50	-3.50						4.50	2.87		
Sandy clayey silt																	
529	5	A-3	TNT	8.0	8.0	2.00	-4.20	-2.10		4.30							
530	5	A-8	TNT	8.0	8.0	2.00	-4.20	-2.10		4.80							
531	5	A-9	TNT	8.0	8.0	2.00	-4.20	-2.10		4.70							
532	5	A-13	TNT	216	216	6.00	-12.60	-2.10		13.50							
533	5	A-24	TNT	1,000	1,000	10.00	-21.00	-2.10	6.20	18.25	1.20	30	2,300				
534	5	A-25	TNT	1,000	1,000	10.00	-21.00	-2.10	4.30	20.75	1.10	19	3,400				

Table 1 (Continued)

(22 of 24 sheets)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS										
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	POSITION		APPARENT										
							Z FT	λ_c	d _a FT	f _a FT	h _a FT	α_a DEG	V _a CU FT	d _t FT	h _t FT	α_t DEG	V _t CU FT		
			Sandy clayey silt (Continued)				Shots Fired with Shaped Charges (Continued)												
535	5	B-11	TNT	64	64	4.00	-8.40	-2.10					10.75						
536	5	B-13	TNT	64	64	4.00	-8.40	-2.10					9.25						
537	5	B-14	TNT	64	64	4.00	-8.40	-2.10					9.65						
538	5	B-15	TNT	64	64	4.00	-8.40	-2.10					9.75						
539	5	B-25	TNT	216	216	6.00	-12.60	-2.10					10.75						
540	5	B-26	TNT	1,000	1,000	10.00	-21.00	-2.10				9.30	18.00	1.80	16	2,590			
541	5	B-32	TNT	1,080	1,080	10.25	-21.00	-2.10					20.50						
542	5	B-33	TNT	64	64	4.00	-8.40	-2.10					8.25						
543	5	B-34	TNT	64	64	4.00	-8.40	-2.10					6.50						
544	5	B-35	TNT	64	64	4.00	-8.40	-2.10					7.50						
545	5	B-36	TNT	8.0	8.0	2.00	-4.20	-2.10					4.00						
546	5	B-37	TNT	8.0	8.0	2.00	-4.20	-2.10					5.35						
547	5	B-38	TNT	8.0	8.0	2.00	-4.20	-2.10					5.25						
548	5	B-39	TNT	8.0	8.0	2.00	-4.20	-2.10					4.25						
549	5	B-40	TNT	8.0	8.0	2.00	-4.20	-2.10					5.50						
550	5	B-41	TNT	8.0	8.0	2.00	-4.20	-2.10					4.50						
Silty sandy clay																			
551	5	A-5	TNT	8.0	8.0	2.00	-4.20	-2.10					4.25						
552	5	A-6	TNT	8.0	8.0	2.00	-4.20	-2.10					4.80						
553	5	A-7	TNT	8.0	8.0	2.00	-4.20	-2.10					4.40						
554	5	B-1	TNT	8.0	8.0	2.00	-4.20	-2.10					4.75						
555	5	B-2	TNT	8.0	8.0	2.00	-4.20	-2.10					5.35						
556	5	B-3	TNT	8.0	8.0	2.00	-4.20	-2.10					5.25						
557	5	B-4	TNT	8.0	8.0	2.00	-4.20	-2.10					5.25						
558	5	B-5	TNT	8.0	8.0	2.00	-4.20	-2.10					5.50						
559	5	B-6	TNT	8.0	8.0	2.00	-4.20	-2.10					5.25						

Table 1 (Continued)

ITEM NO.	SHOT SOURCE NUMBER	EXPLOSIVE TYPE	EXPLOSIVE DATA			CHARGE POSITION		CRATER DIMENSIONS									
			CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	d _g FT	r _g FT	h _g FT	α _g DEG	V _g CU-FT	d _t FT	r _t FT	α _t DEG	V _t CU-FT	
Silty sandy clay (Continued)																	
Shots Fired with Shaped Charges (Continued)																	
560	5	B-7 TNT	8.0	8.0	2.00	-4.20	-2.10			5.55							
561	5	B-8 TNT	8.0	8.0	2.00	-4.20	-2.10			5.25							
562	5	B-9 TNT	8.0	8.0	2.00	-4.20	-2.10			5.15							
563	5	B-10 TNT	64	64	4.00	-8.40	-2.10			9.90							
564	5	B-12 TNT	64	64	4.00	-8.40	-2.10			9.35							
Various soils																	
565	5	A-1 TNT	8.0	8.0	2.00	-4.20	-2.10			4.15							
566	5	A-2 TNT	8.0	8.0	2.00	-4.20	-2.10			4.65							
567	5	A-4 TNT	8.0	8.0	2.00	-4.20	-2.10			4.25							
568	5	A-10 TNT	64	64	4.00	-8.40	-2.10			8.00							
569	5	A-11 TNT	64	64	4.00	-8.40	-2.10			8.75							
570	5	A-12 TNT	216	216	6.00	-12.60	-2.10			8.95							
571	5	A-14 TNT	308	308	6.75	-14.20	-2.10			11.50							
572	5	A-15 TNT	308	308	6.75	-14.20	-2.10			14.25							
573	5	A-16 TNT	308	308	6.75	-14.20	-2.10			13.50							
574	5	A-17 TNT	64	64	4.00	-8.40	-2.10			8.80							
575	5	A-18 TNT	512	512	8.00	-16.80	-2.10			15.00							
576	5	50/50 Amatol	540			-17.00				16.25							
577	5	50/50 Amatol	540			-17.00				18.75							
578	5	A-21 TNT	512	512	8.00	-16.80	-2.10			15.75							
579	5	A-22 TNT	512	512	8.00	-16.80	-2.10			17.50							
580	5	A-23 TNT	216	216	6.00	-12.60	-2.10			12.50							
581	5	50/50 Amatol	1,080			-21.00				8.40	22.10	2.0	39	3,130			
582	5	50/50 Amatol	1,080			-21.00				4.80	23.50	1.70	23	2,515			
583	5	A-28 TNT	1,000	1,000	10.00	-21.00	-2.10			6.90	19.25	2.30	27	2,640			
584	5	50/50 Amatol	3,200			-31.00				9.80	23.50	3.80	32	3,135			

Table 2
Results of Camouflet Measurements in Soil

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT					CAMOUFLET																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
									d _a FT	l _a FT	h _a FT	α _a DEG	V _a CU FT	D _v FT	D _h FT	l _f FT	V _c CU FT																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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* Numbers correspond to Bibliography numbers.

** Above original ground surface.

Table 3
Results of Crater Measurements in Frozen Ground

ITEM SOURCE SHOT NUMBER			EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS									
									APPARENT				TRUE					
							EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT
638	23	103	Military C-3	19.61			-1.06		2.24	5.31			68.79					
639	22	311	Coalite 7-S	0.66			-0.42		0.79	1.04			1.00					
640	22	312	Coalite 7-S	0.66			-0.42		0.94	1.14			1.41					
641	22	313	Coalite 7-S	0.66			-0.42		0.79	1.28			1.42					
642	23	104	Military C-3	19.51			-1.53		3.14	5.65			94.05					
643	22	292	Gelodyn 1	0.38			-0.43		0.71	1.16			1.31					
644	22	293	Gelodyn 1	0.38			-0.43		0.79	0.99			1.01					
645	22	294	Gelodyn 1	0.38			-0.43		Waterlogged crater									
646	23	140	Coalite 7-S	20.04			-1.80		3.39	4.16			87.07					
647	22	279	60% gelatin	0.22			-0.46		0.79	1.21			1.00					
648	22	10	Gelodyn 1	0.488			-0.56		1.00	1.29			1.89					
649	22	19	Coalite 7-S	0.483			-0.56		1.20	1.20			1.66					
650	23	82	Military C-3	0.50			-0.57		0.95	1.41			3.28					
651	22	18	Coalite 7-S	0.560			-0.59		0.96	1.70			3.06					
652	52	1	Pentolite	2.65			-1.0		2.6	2.7			26.1					
653	52	2	Pentolite	2.65			-1.0		2.5	3.0			33.6					
654	52	3	Pentolite	2.65			-1.0		2.4	3.2			25.1					
655	52	4	Pentolite	2.65			-1.0		2.4	3.1			44.5					
656	52	5	Pentolite	2.65			-1.0		2.2	2.9			39.5					
657	52	6	Pentolite	2.65			-1.0		1.7	2.7			22.5					
658	52	7	Pentolite	2.65			-1.0		1.5	3.5			19					
659	52	8	Pentolite	2.65			-1.0		1.7	2.9			21.2					
660	52	9	Pentolite	2.65			-1.0		1.2	2.9			16.1					
661	52	10	Pentolite	2.65			-1.0		1.7	3.7			16.6					
662	52	11	Pentolite	2.65			-1.0		1.9	3.3			21.1					
663	52	12	Pentolite	2.65			-1.0		1.9	3.4			27.6					
664	52	13	Pentolite	2.65			-1.0		1.5	3.1			13.3					
665	52	14	Pentolite	2.65			-1.0		1.8	3.7			12.8					

* Numbers correspond to Bibliography numbers.

Table 3 (Continued)

(2 of 21 sheets)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS									
			EXPLOSIVE TYPE	CHARGE WEIGHT = LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT			TRUE						
									d _a FT	r _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	r _t FT	α _t DEG	V _t CU FT	
666	52	106	C-3	2.65			-1.0	1.9	4.0			25.0						
667	22	296	Coalite 7-S	0.85			-0.69											
668	23	94	Military C-3	1.00			-0.73	1.28	2.08			6.24						
669	22	277	60% gelatin	0.22			-0.45	0.79	1.17			1.36						
670	22	278	60% gelatin	0.22			-0.45	0.81	1.03			1.04						
671	22	1	60% gelatin	0.472			-0.58	1.0	1.52			2.42						
672	23	115-R	Coalite 7-S	1.98			-0.95	1.82	2.56			18.46						
673	22	368	Coalite 7-S	0.66			-0.66	1.23	1.49			3.17						
674	22	309	Coalite 7-S	0.66			-0.66	1.12	1.17			1.88						
675	22	310	Coalite 7-S	0.66			-0.66	1.25	1.23			2.37						
676	22	11	Gelodyn 1	0.425			-0.58	0.96	1.44			2.31						
677	23	105	Military C-3	19.39			-2.06	3.35	5.28			105.77						
678	23	83	Military C-3	0.50			-0.63	1.06	1.69			4.83						
679	22	244	80% gelatin	0.20			-0.48	0.83	1.20			1.72						
680	22	245	80% gelatin	0.20			-0.48	0.87	1.12			1.35						
681	22	246	80% gelatin	0.20			-0.48	0.79	1.03			0.90						
682	22	297	Coalite 7-S	1.30			-0.83	1.00	1.05			1.15						
683	23	62	Military C-3	1.19			-1.02	1.57	2.92			14.03						
684	22	2	60% gelatin	0.412			-0.60	2.50	1.50			3.64						
685	22	20	Coalite 7-S	0.413			-0.61	1.04	1.48			2.30						
686	23	36	Atlas 60	1.90			-1.02	1.58	2.33			10.09						
687	23	116-R	Coalite 7-S	1.98			-1.09	1.83	2.53			17.60						
688	22	13	60% gelatin	0.353			-0.64	2.16	1.17			3.04						
689	23	74	Military C-3	4.90			-1.52	2.36	4.01			44.70						
690	23	84	Military C-3	0.50			-0.71	0.99	1.83			3.67						
691	23	54	Atlas 60	19.04			-2.46	4.00	5.77			121.25						
692	23	141	Coalite 7-S	20.05			-2.51	3.94	5.13			140.83						
693	22	291	Gelodyn 1	0.38			-0.67	1.06	1.17			1.64						

Table 3 (Continued)

(3 of 21 sheets)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA			CHARGE POSITION		CRATER DIMENSIONS						TRUE	
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ_c	d _s FT	r _a FT	h _a FT	α_a DEG	V _a CU FT	d _t FT	V _t CU FT
694	23	46	Atlas 60	4.82			-1.57		2.34	3.90			31.77		
695	22	289	Gelodyn 1	0.38			-0.68		1.08	1.30			2.00		
696	22	290	Gelodyn 1	0.38			-0.68		0.98	1.38			2.40		
697	22	13	Gelodyn 1	0.307			-0.64		1.42	1.10			1.87		
698	22	12	Gelodyn 1	0.362			-0.08		1.25	0.99			1.51		
699	23	85	Military C-3	0.50			-0.76		0.96	1.83			3.54		
700	23	106	Military C-3	19.52			-2.58		4.19	5.86			175.11		
701	22	21	Coalite 7-S	0.350			-0.68		1.29	1.36			1.92		
702	22	47	Gelodyn 1	0.486			-0.76		1.50	1.44			3.08		
703	23	28	Atlas 60	0.95			-0.96		1.45	2.01			5.22		
704	23	37	Atlas 60	1.90			-1.22		1.69	3.14			12.63		
705	22	38	60% gelatin	0.472			-0.77		1.75	1.58			3.70		
706	23	22	Atlas 60	0.48			-0.77		1.15	1.90			3.74		
707	23	133	Coalite 7-S	4.93			-1.68		2.47	3.16			43.25		
708	22	37	60% gelatin	0.029			-0.31								
709	22	56	Coalite 7-S	0.562			-0.84		1.50	1.14			2.52		
710	23	63	Military C-3	1.99			-1.28		2.13	2.01			14.88		
711	22	305	Coalite 7-S	0.66			-0.92		1.58	1.27			2.60		
712	22	306	Coalite 7-S	0.66			-0.92		1.46	1.35			3.00		
713	22	307	Coalite 7-S	0.66			-0.92		1.83	1.43			4.29		
714	23	134	Coalite 7-S	4.92			-1.83		2.77	3.10			36.00		
715	22	39	60% gelatin	0.443			-0.81		2.08†	1.51			5.66		
716	23	117	Coalite 7-S	1.98			-1.37		1.88	2.43			12.88		
717	52	15	Pentolite	2.65			-1.5		2.2	3.8			18.5		
718	52	16	Pentolite	2.65			-1.5		2.1	3.6			19.0		
719	52	17	Pentolite	2.65			-1.5		1.8	3.6			22.4		
720	52	18	Pentolite	2.65			-1.5		2.4	3.0			19.2		
721	52	19	Pentolite	2.65			-1.5		2.3	3.3			23.0		

† Broke through interface of unfrozen ground.

Table 3 (Continued)

(4 of 21 sheets)

ITEM SOURCE NUMBER			EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λc	da FT	ra FT	ha FT	αa DEG	Va CU FT	dt FT	rt FT	αt DEG	Vt CU FT
722	52	20	Pentolite	2.65			-1.5		2.1	3.1			20.8				
723	52	21	Pentolite	2.65			-1.5		2.0	3.4			22.0				
724	52	22	Pentolite	2.65			-1.5		2.2	4.3			42.6				
725	52	23	Pentolite	2.65			-1.5		2.4	2.9			25.9				
726	52	24	Pentolite	2.65			-1.5		1.7	2.4			11.9				
727	52	25	Pentolite	2.65			-1.5		2.0	2.8			11.5				
728	52	26	Pentolite	2.65			-1.5		2.3	2.7			19.8				
729	52	27	Pentolite	2.65			-1.5		1.9	2.6			15.5				
730	52	28	Pentolite	2.65			-1.5		1.8	2.7			18.5				
731	52	107	C-3	2.65			-1.5		1.8	3.7			22.5				
732	23	107	Military C-3	19.96			-2.97		4.53	6.45			208.28				
733	23	142	Coalite 7-S	20.06			-2.98		4.65	5.79			253.92				
734	23	55	Atlas 60	19.03			-2.96		4.35	6.22			161.64				
735	22	49	Gelodyn 1	0.424			-0.84		2.66†	1.45			7.17				
736	23	47	Atlas 60	4.81			-1.90		2.89	4.14			35.72				
737	23	38	Atlas 60	1.89			-1.40		2.17	3.38			17.44				
738	22	4	60% gelatin	0.294			-0.75		1.42	1.41			2.75				
739	22	57	Coalite 7-S	0.484			-0.90		2.08	1.41			4.83				
740	23	95	Military C-3	1.00			-1.14		1.66	2.50			11.52				
741	22	275	60% gelatin	0.22			-0.69		0.83	1.08			1.34				
742	22	14	Gelodyn 1	0.244			-0.71		1.12	1.12			1.89				
743	22	22	Coalite 7-S	0.274			-0.75		1.04	1.31			2.10				
744	23	64-R	Military C-3	2.00			-1.45		2.11	3.34			26.34				
745	23	86	Military C-3	0.50			-0.92		1.20	1.68			3.31				
746	22	274	60% gelatin	0.22			-0.70		0.90	1.09			1.38				
747	22	276	60% gelatin	0.22			-0.70		0.96	1.23			2.04				
748	22	40	60% gelatin	0.35			-0.83		2.42†	1.56			5.95				
749	23	64	Military C-3	1.99			-1.48		2.10	2.26			10.96				

† Broke through interface of unfrozen ground.

Table 3 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS							
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ¹ 3 LB ¹ 3	Z FT	λ _c	APPARENT						TRUE	
									d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG
750	22	5	60% gelatin	0.236			-0.73		1.16	1.15		1.71				
751	22	49	Gelodyn 1	0.364			-0.85		2.00	1.43		4.16				
752	23	135	Coalite 7-S	4.94			-2.04		2.96	2.96		41.12				
753	23	29	Atlas 60	0.95			-1.19		1.67	2.07		9.46				
754	23	75	Military C-3	4.94			-2.05		2.89	3.79		40.00				
755	22	15	Gelodyn 1	0.181			-0.70		0.92	1.31		1.67				
756	23	48	Atlas 60	4.69			-2.06		2.84	4.32		34.56				
757	23	87	Military C-3	0.50			-0.98		1.31	2.28		5.72				
758	22	58	Coalite 7-S	0.415			-0.94		2.25	1.36		4.54				
759	22	241	8% gelatin	0.20			-0.73		1.12	1.13		2.76				
760	22	242	3% gelatin	0.20			-0.73		1.00	1.00		1.19				
761	22	243	8% gelatin	0.20			-0.73		1.15	1.24		2.22				
762	22	288	Gelodyn 1	0.38			-0.92		1.25	1.33		2.67				
763	23	56	Atlas 60	19.13			-3.44		4.94	5.58		161.79				
764	23	143	Coalite 7-S	20.10			-3.48		4.40	5.89		229.86				
765	22	36	60% gelatin	0.229			-0.40		0.58	0.77		0.39				
766	22	286	Gelodyn 1	0.38			-0.93		1.29	1.10		2.33				
767	22	287	Gelodyn 1	0.38			-0.93		1.31	1.41		3.44				
768	23	118	Coalite 7-S	1.96			-1.61		2.30	2.87		21.87				
769	22	23	Coalite 7-S	0.210			-0.79		1.17	1.04		1.37				
770	22	302	Coalite 7-S	0.66			-1.17		1.83	1.57		6.35				
771	22	303	Coalite 7-S	0.66			-1.17		2.21	1.54		6.16				
772	22	304	Coalite 7-S	0.66			-1.17		1.87	1.42		5.40				
773	23	108	Military C-3	19.59			-3.63		5.09	6.82		287.14				
774	23	96	Military C-3	1.00			-1.35		1.70	2.48		8.66				
775	22	41	60% gelatin	0.295			-0.91		2.33†	1.69		6.78				
776	22	50	Gelodyn 1	0.373			-0.91		2.50	1.54		5.83				
777	22	59	Coalite 7-S	0.346			-0.95		2.25	1.70		6.98				

† Broke through interface of unfrozen ground.

Table 3 (Continued)

(6 of 21 sheets)

ITEM NO.			SOURCE NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS							
				EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ_c	d ₃ FT	t _a FT	h _a FT	α_a DEG	V _a CU FT	d _t FT	r _t FT	α_t DEG
778	23	136	Coalite 7-S	4.92				-2.34		3.31	3.83			42.86			
779	22	42	60% gelatin	0.236				-0.87		1.50	1.67			3.95			
780	23	39	Atlas 60	1.90				-1.74		2.37	3.51			22.31			
781	23	119	Coalite 7-S	1.98				-1.76		2.56	2.84			23.78			
782	23	65	Military C-3	1.99				-1.77		2.48	2.70			22.73			
783	22	6	60% gelatin	0.177				-0.79		1.00	0.97			1.45			
784	23	2	Atlas 60	1.96				-1.76		2.67	2.67			13.32			
785	22	320	Coalite 7-S	0.26				-0.91		1.29	1.09			2.11			
786	23	23	Atlas 60	0.48				-1.11		1.51	2.12			5.75			
787	22	24	Coalite 7-S	0.140				-0.75		1.08	1.25			1.87			
788	23	30	Atlas 60	0.92				-1.40		1.86	2.30			8.61			
789	23	6	Atlas 60	1.92				-1.79		2.46	2.88			17.41			
790	23	7	Atlas 60	1.92				-1.79		2.65	2.53			11.03			
791	23	42	Atlas 60	1.94				-1.80		2.62	3.00			15.80			
792	22	317	Coalite 7-S	0.26				-0.93		1.33	1.32			2.46			
793	22	318	Coalite 7-S	0.26				-0.93		1.40	1.10			1.82			
794	22	319	Coalite 7-S	0.26				-0.93			0.56		No crater				
795	52	29	Pentolite	2.65				-2.0		2.3	4.0			36.4			
796	52	30	Pentolite	2.65				-2.0		2.2	3.3			26.3			
797	52	31	Pentolite	2.65				-2.0		2.4	3.5			26.9			
798	52	32	Pentolite	2.65				-2.0		1.5	4.0			35.8			
799	52	33	Pentolite	2.65				-2.0		1.9	3.1			20.4			
800	52	34	Pentolite	2.65				-2.0		2.1	3.3			19.1			
801	52	35	Pentolite	2.65				-2.0		2.3	3.4			27.5			
802	52	36	Pentolite	2.65				-2.0		3.0	3.3			24.5			
803	52	37	Pentolite	2.65				-2.0		1.7	3.4			17.7			
804	52	38	Pentolite	2.65				-2.0		2.7	3.4			26.5			
805	52	39	Pentolite	2.65				-2.0		1.7	3.9			25.7			

Table 3 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS						
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	d _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	α _t DEG	V _t CU FT
806	52	4c	Pentolite	2.65			-2.0		2.2	3.2		28.1			
807	52	41	Pentolite	2.65			-2.0		1.7	3.4		20.7			
808	52	42	Pentolite	2.65			-2.0		1.7	3.1		14.2			
809	52	108	C-3	2.65			-2.0		2.5	3.7		22.7			
810	22	60	Coalite 7-S	0.277			-0.95		1.33	1.51		3.83			
811	22	169	Coalite 7-S	1.77			-1.77		3.00	3.15		39.65			
812	22	323	Coalite 7-S	0.26			-0.94		1.21	0.97		1.18			
813	22	324	Coalite 7-S	0.26			-0.94		1.29	1.27		2.58			
814	22	325	Coalite 7-S	0.26			-0.94		1.29	1.32		2.73			
815	22	160	Coalite 7-S	0.44			-1.12		2.29	1.27		4.48			
816	23	88-R	Military C-2	0.50			-1.16		1.53	2.37		5.87			
817	22	316-A	Coalite 7-S	0.26			-0.95		1.60	1.04		1.70			
818	22	321	Coalite 7-S	0.26			-0.95			0.96	No crater				
819	22	322	Coalite 7-S	0.26			-0.95			0.89	No crater				
820	22	163	Coalite 7-S	0.75			-1.35		2.50	1.69		9.44			
821	22	166	Coalite 7-S	1.18			-1.37		2.92	2.24		19.34			
822	23	9	Atlas 60	1.92			-1.84		2.55	2.88		14.36			
823	23	11	Atlas 60	1.92			-1.84		2.67	3.14		15.05			
824	23	49	Atlas 60	4.70			-2.49		3.53	4.56		48.63			
825	23	57	Atlas 60	18.99			-3.97		5.54	6.44		232.51			
826	22	326	Coalite 7-S	0.26			-0.96			0.69	No crater				
827	22	327	Coalite 7-S	0.26			-0.96			0.58	No crater				
828	22	328	Coalite 7-S	0.26			-0.96			0.67	No crater				
829	23	3	Atlas 60	1.95			-1.88		2.41	2.51		13.54			
830	23	109	Military C-3	19.68			-4.05		5.45	6.40		275.36			
831	22	157	Coalite 7-S	0.225			-0.92		1.33	1.15		1.16			
832	22	162	Coalite 7-S	0.60			-1.27		2.75	1.81		9.82			
833	23	144	Coalite 7-S	20.16			-4.11††		4.57	5.35		167.33			

†† Shot fired in drift area.

Table 3 (Continued)

EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS									
ITEM NO.	SOURCE NUMBER	EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λc	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	α _t DEG	V _t CU FT
834	23	4	Atlas 60	1.93		-1.86		2.31	2.86			13.76			
835	23	76	Military C-3	4.92		-2.59		3.47	4.05			65.13			
836	23	8	Atlas 60	1.91		-1.90		2.52	2.96			15.02			
837	23	146	Coalite 7-S	20.14		-4.17		5.56	5.18			240.01			
838	22	16	Gelodyn 1	0.125		-0.77		1.00	1.17			1.69			
839	22	35	60% gelatin	0.029		-0.48		0.62	1.15			1.18			
840	22	272	60% gelatin	0.22		-0.93		1.46	1.39			2.85			
841	22	73	Coalite 7-S	0.207		-0.92			Charging error						
842	22	316	Coalite 7-S	0.26		-1.00			0.35		No crater				
843	23	1	Atlas 60	1.86		-1.92		2.67	2.45			13.29			
844	23	10	Atlas 60	1.93		-1.95		2.75	2.84			12.13			
845	23	66	Military C-3	1.99		-1.96		2.79	3.30			27.63			
846	22	7	60% gelatin	0.118		-0.77		1.00	1.28			1.41			
847	23	5	Atlas 60	1.92		-1.95		7.75	2.57			18.72			
848	22	51	Gelodyn 1	0.242		-0.98		1.59	1.74			5.07			
849	23	16	Atlas 60	1.93		-1.98		2.34	3.03			28.65			
850	22	91	Coalite 7-S	0.191		-0.92			Crater						
851	23	40	Atlas 60	1.88		-1.96		2.56	3.24			17.63			
852	22	224	80% gelatin	0.11		-0.77									
853	22	273	60% gelatin	0.22		-0.96		1.50	1.25			2.84			
854	23	41	Atlas 60	1.91		-1.98		2.54	3.34			26.26			
855	22	156	Coalite 7-S	0.185		-0.92		2.08	1.15			2.25			
856	22	76	Coalite 7-S	0.207		-0.95			Crater						
857	22	85	Coalite 7-S	0.207		-0.95									
858	22	314	Coalite 7-S	0.26		-1.03			0.63		No crater				
859	22	315	Coalite 7-S	0.26		-1.03			0.33		No crater				
860	22	61	Coalite 7-S	0.205		-0.96		1.92	1.49			4.48			
861	22	159	Coalite 7-S	0.365		-1.12		1.92	1.33			4.01			

Table 3 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		APPARENT						TRUE			
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ ^c	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT	
862	22	285	Gelodyn 1	0.38			-1.17		1.16	1.60			5.06					
863	22	271	60% gelatin	0.22			-0.98		1.73	1.34			3.00					
864	22	260	Coalite 7-S	0.66			-1.42			No crater								
865	22	299	Coalite 7-S	0.66			-1.42		0.01	0.65		No crater						
866	22	300	Coalite 7-S	0.66			-1.42		1.92	1.90			7.09					
867	22	301	Coalite 7-S	0.66			-1.42		2.29	1.30			3.62					
868	22	165	Coalite 7-S	0.954			-1.60		3.42	1.90			17.09					
869	23	145	Coalite 7-S	20.10			-4.44††		5.17	5.83			293.40					
870	22	43	60% gelatin	0.177			±0.92		1.42	1.40			3.55					
871	22	110	Coalite 7-S	0.178			-0.93											
872	22	283	Gelodyn 1	0.38			-1.18		1.90	1.36			4.06					
873	22	284	Gelodyn 1	0.38			-1.18		1.80	1.18			3.50					
874	22	282	Coalite 7-S	0.68			-1.44											
875	22	263	Coalite 7-S	0.68			-1.44											
876	22	163	Coalite 7-S	1.40			-1.84		3.25	3.19			39.15					
877	22	269	Coalite 7-S	0.63			-1.42			No crater								
878	22	261	Coalite 7-S	0.68			-1.45											
879	22	264	Coalite 7-S	0.68			-1.45			No crater								
880	23	13	Atlas 60	1.89			-2.05		2.71	3.20			30.85					
881	23	14	Atlas 60	1.93			-2.06		2.66	2.92			26.42					
882	23	18	Atlas 60	1.99			-2.08		2.59	3.44			36.44					
883	23	110	Military C-3	19.84			-4.48		5.90	7.08			353.87					
884	22	295	Coalite 7-S	0.025			-0.48											
885	22	72	Coalite 7-S	0.179			-0.93			Charging error								
886	22	96	Coalite 7-S	0.191			-0.96			Crater								
887	22	97	Coalite 7-S	0.191			-0.96			Crater								
888	23	120	Coalite 7-S	1.97			-2.08		2.75	3.30			32.46					
889	22	112	Coalite 7-S	0.178			-0.94		1.25	1.26			2.11					

†† Shot fired in drift area.

Table 3 (Continued)

(10 of 21 sheets)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION	CRATER DIMENSIONS											
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}		APPARENT					TRUE						
								d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT			
890	22	240	30% gelatin	0.20			-0.97		1.29	1.30				2.63					
891	23	58	Atlas 60	19.21			-1.48		6.46	7.04				306.85					
892	22	238	30% gelatin	0.20			-0.98		1.25	1.19				2.15					
893	22	239	30% gelatin	0.20			-0.98		1.35	1.03				2.25					
894	23	24	Atlas 60	3.48			-1.32		1.70	2.57				7.70					
895	22	84	Coalite 7-S	0.179			-0.95												
896	22	52	Gelodyn 1	0.181			-0.97		2.00	1.26				3.09					
897	23	31	Atlas 60	0.94			-1.67		2.15	2.69				17.97					
898	22	111	Coalite 7-S	0.178			-0.96												
899	22	90	Coalite 7-S	0.191			-0.99				No crater								
900	23	17	Atlas 60	1.92			-2.13		2.66	3.70				45.21					
901	22	75	Coalite 7-S	0.179			-0.97				Crater								
902	22	134	50% gelatin	0.302			-1.16												
903	23	67-R	Military C-3	2.00			-2.21		2.88	3.79				36.51					
904	22	102	Coalite 7-S	0.165			-0.97				No crater								
905	22	103	Coalite 7-S	0.165			-0.97				No crater								
906	23	15	Atlas 60	1.91			-2.18		2.74	3.28				40.43					
907	22	175	Gelodyn 1	0.14			-0.92				No crater								
908	22	83	Coalite 7-S	0.153			-0.96				No crater								
909	23	126	Coalite 7-S	4.93			-3.02			3.98									
910	22	223	80% gelatin	0.08			-0.77				Crater								
911	22	167	Coalite 7-S	1.07			-1.83		3.08	1.70				8.69					
912	23	50	Atlas 60	4.78			-3.01		3.13	4.69				67.45					
913	22	164	Coalite 7-S	0.71			-1.60		1.56	1.10				3.65					
914	52	43	Pentolite	2.65			-2.5		2.1	3.3				21.5					
915	52	44	Pentolite	2.65			-2.5		2.1	3.6				17.2					
916	52	45	Pentolite	2.65			-2.5		1.7	3.7				19.6					
917	52	46	Pentolite	2.65			-2.5		2.2	3.7				28.3					

Table 3 (Continued)

ITEM SOURCE SHOT NUMBER			EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS							
									APPARENT			TRUE				
									d _a FT	r _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	n FT	α _t DEG
918	52	47	Pentolite	2.65		-2.5		3.1	4.8			39.1				
919	52	48	Pentolite	2.65		-2.5		2.5	3.7			34.5				
920	52	49	Pentolite	2.65		-2.5		2.7	4.2			48.5				
921	52	50	Pentolite	2.65		-2.5		2.8	5.0			58.6				
922	52	51	Pentolite	2.65		-2.5		2.6	4.1			34.5				
923	52	52	Pentolite	2.65		-2.5		2.9	4.5			56.3				
924	52	53	Pentolite	2.65		-2.5		3.5	5.1			107.5				
925	52	54	Pentolite	2.65		-2.5		3.3	3.9			54.1				
926	52	55	Pentolite	2.65		-2.5		3.3	4.0			66.5				
927	52	56	Pentolite	2.65		-2.5		3.6	4.2			50.6				
928	52	109	C-3	2.65		-2.5			No crater							
929	22	34	60% gelatin	0.029		-0.56		0.71	0.97			0.75				
930	22	71	Coalite 7-S	0.153		-0.98			Charging error							
931	23	97	Military C-3	1.00		-1.81		2.34	2.91			17.73				
932	22	298	Coalite 7-S	0.180		-1.02		1.21	1.2			1.82				
933	23	67	Military C-3	1.99		-2.29		2.73	3.77			32.96				
934	22	74	Coalite 7-S	0.153		-0.99			No crater							
935	22	161	Coalite 7-S	0.44		-1.40		2.75	0.80			0.80				
936	22	158	Coalite 7-S	0.27		-1.20		2.08	0.00							
937	23	111	Military C-3	19.87		-5.01		6.39	6.91			459.05				
938	23	121	Coalite 7-S	1.96		-2.33		3.23	3.06			48.24				
939	23	59	Atlas 60	19.26		-4.98		6.32	6.71			294.18				
940	22	178	Gelodyn 1	0.44		-1.42										
941	23	42	Atlas 60	1.92		-2.32		3.03	4.25			54.10				
942	22	172	Gelodyn 1	0.075		-0.79			No crater							
943	22	174	Gelodyn 1	0.115		-0.92			No crater							
944	22	89	Gelodyn 1	0.125		-0.94			No crater							
945	22	181	Gelodyn 1	1.43		-2.12		3.79	2.83			42.63				

Table 3 (Continued)

			EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	CHARGE POSITION		APPARENT						TRUE		
							Z FT	λc	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	r _t FT	α _t DEG	V _t CU FT
946	23	127	Coalite 7-S	5.00			-3.24		4.15	4.46			76.76				
947	22	62	Coalite 7-S	0.138			-0.99				No crater						
948	22	201	80% gelatin	0.090			-0.86			0.63	2-in. crater						
949	23	77	Military C-3	4.05			-3.06		3.72	4.87			75.35				
950	22	70	Gelodyn 1	0.125			-0.96										
951	23	147	Coalite 7-S	20.15			-5.22††		5.87	6.23			355.33				
952	22	25	Coalite 7-S	0.070			-0.79		0.15	0.40			0.03				
953	22	199	80% gelatin	0.085			-0.85		1.15	1.81			2.99				
954	22	200	80% gelatin	0.090			-0.87		1.21	1.38			1.82				
955	22	202	80% gelatin	0.100			-0.89		1.21	2.23		3-in. crater					
956	22	203	80% gelatin	0.100			-0.89		3.27	0.81			4.26				
957	23	123	Coalite 7-S	1.96			-2.43										
958	22	185	Gelodyn 1	14.82			-4.75			9.56							
959	22	53	Gelodyn 1	0.122			-0.97		0.15	0.75			0.11				
960	23	32	Atlas 60	0.95			-1.90		2.33	3.24			19.01				
961	23	66-R	Military C-3	2.00			-2.45		3.14	3.94			43.00				
962	22	255	Gelodyn 1	0.39			-1.42										
963	23	89	Military C-3	0.50			-1.54		1.99	2.75			17.50				
964	22	82	Gelodyn 1	0.125			-0.98										
965	22	17	Gelodyn 1	0.063			-0.79		0.17	0.48			0.04				
966	22	28	Coalite 7-S	0.063			-0.79		0.08	0.31			0.00				
967	22	198	80% gelatin	0.085			-0.87		0.25	0.33			0.04				
968	22	88	Gelodyn 1	0.125			-0.99				Crater						
969	22	268	60% gelatin	0.22			-1.19		1.50	1.74			5.10				
970	23	68	Military C-3	1.99			-2.49		3.04	3.09			27.90				
971	22	254	Gelodyn 1	0.38			-1.43										
972	22	280	Gelodyn 1	0.38			-1.43		2.67	0.84			2.57				
973	22	281	Gelodyn 1	0.38			-1.43		1.92	1.99			4.43				

†† Shot fired in drift area.

(13 of 27 sheets)

[illegible]

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS									
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT				TRUE					
									d _a FT	l _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	l _t FT	α _t DEG	V _t CU FT	
1002	23	25	Atlas 60	0.46			-1.58		2.04	2.38					11.97			
1003	23	51	Atlas 60	4.74			-3.44		4.15	4.87					99.65			
1004	23	148	Coalite 7-S	20.12			-5.58		6.93	6.17					419.62			
1005	22	148	60% gelatin	0.321			-1.42		2.33	1.60					4.09			
1006	22	183	Gelodyn 1	5.40			-3.61			6.06								
1007	22	133	60% gelatin	0.321			-1.43			No crater								
1008	22	180	Gelodyn 1	1.18			-2.19		3.58	2.90					40.40			
1009	22	8	60% gelatin	0.059			-0.81		0.92	1.12					1.06			
1010	22	171	Gelodyn 1	0.06			-0.81			No crater								
1011	22	235	80% gelatin	0.21			-1.23		2.00	1.73					4.11			
1012	22	236	80% gelatin	0.21			-1.23		1.44	1.55					3.78			
1013	23	128	Coalite 7-S	4.96			-3.53		4.47	3.65					20.11			
1014	22	124	60% gelatin	0.103			-0.98			Muddy surface								
1015	23	43	Atlas 60	1.89			-2.60		3.37	4.18					49.64			
1016	22	78	60% gelatin	0.089			-0.95			Crater								
1017	22	121	60% gelatin	0.092			-0.95		0.21	1.27					0.41			
1018	23	19	Atlas 60	1.98			-2.66		----	4.71					15.06			
1019	23	78	Military C-3	4.81			-3.56		2.72	6.33					69.22			
1020	22	145	60% gelatin	0.184			-1.21		2.08	1.32					3.57			
1021	22	237	80% gelatin	0.20			-1.23		1.33	1.25					2.59			
1022	22	136	60% gelatin	0.505			-1.70											
1023	22	154	60% gelatin	0.749			-1.93		3.59	3.09					42.15			
1024	22	33	60% gelatin	0.029			-0.66		0.10	0.33					0.00			
1025	22	66	60% gelatin	0.089			-0.96			Crater								
1026	22	87	60% gelatin	0.090			-0.96			Crater								
1027	22	68	Gelodyn 1	0.098			-0.98											
1028	23	122	Coalite 7-S	1.97			-2.66		3.25	3.23					42.64			
1029	22	27	Coalite 1	0.06			-0.70											

Table 3 (Continued)

(15 of 21 sheets)

			EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT				TRUE				
									d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT
1030	22	209	80% gelatin	0.082			-0.92		1.12	1.41			2.42				
1031	22	142	60% gelatin	0.085			-0.94		1.21	1.27			2.01				
1032	22	139	60% gelatin	0.170			-1.97										
1033	52	57	Pentolite	2.65			-3.0		4.0	4.8			110.0				
1034	52	58	Pentolite	2.65			-3.0		4.4	5.5			123.0				
1035	52	59	Pentolite	2.65			-3.0		3.3	4.7			74.4				
1036	52	60	Pentolite	2.65			-3.0		3.4	4.5			64.9				
1037	52	61	Pentolite	2.65			-3.0		3.6	5.4			91.2				
1038	52	62	Pentolite	2.65			-3.0		3.9	4.8			123.0				
1039	52	63	Pentolite	2.65			-3.0		3.5	5.4			80.0				
1040	52	64	Pentolite	2.65			-3.0		3.7	5.9			94.0				
1041	52	65	Pentolite	2.65			-3.0		3.1	5.1			57.9				
1042	52	66	Pentolite	2.65			-3.0		3.5	5.8			62.2				
1043	52	67	Pentolite	2.65			-3.0			No crater							
1044	52	68	Pentolite	2.65			-3.0		3.5	4.9			66.3				
1045	52	69	Pentolite	2.65			-3.0		3.1	6.0			76.8				
1046	52	70	Pentolite	2.65			-3.0		3.8	6.8			131.0				
1047	52	110	C-3	2.65			-3.0		3.7	4.9			43.2				
1048	22	173	Gelodyn 1	0.085			-0.96			No crater							
1049	22	120	60% gelatin	0.089			-0.98										
1050	22	249	60% gelatin	0.27			-1.42										
1051	22	210	80% gelatin	0.31			-1.48		2.33	1.55			5.86				
1052	22	211	80% gelatin	0.31			-1.48		2.58	1.55			7.81				
1053	22	119	60% gelatin	0.085			-0.97		----	----			0.29				
1054	22	86	60% gelatin	0.090			-0.99				Crater						
1055	23	33	Atlas 60	0.98			-2.18		2.56	3.23			21.33				
1056	23	69	Military C-3	1.99			-2.77		3.11	4.49			70.10				
1057	22	197	80% gelatin	0.075			-0.93				Collar circle						

Table 3 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1.3} LB ^{1.3}	Z FT	λc	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _i FT	η FT	α _i DEG	V _i CU FT
1058	23	129	Coalite 7-S	4.96			-3.78		1.57	2.16			0.85				
1059	23	60	Atlas 60	19.08			-5.94										
1060	22	32	60% gelatin	0.029			-0.69		0.83	1.19			1.18				
1061	22	117	60% gelatin	0.078			-0.96		1.25	1.37			2.70				
1062	22	127	60% gelatin	0.085			-0.98										
1063	22	179	Gelodyn 1	0.87			-2.12		3.46	2.44			25.79				
1064	23	113	Military C-3	19.92			-6.03			2.24							
1065	22	196	80% gelatin	0.075			-0.94			Collar circle							
1066	22	170	Gelodyn 1	0.045			-0.81			No crater							
1067	22	147	60% gelatin	0.258			-1.44		2.08	1.66			2.89				
1068	22	222	80% gelatin	0.04			-0.77										
1069	22	207	80% gelatin	0.082			-0.97		1.25	1.68			3.50				
1070	22	151	60% gelatin	0.503			-1.81		2.75	1.61			7.55				
1071	22	118	60% gelatin	0.081			-0.98		1.25	1.27			2.29				
1072	22	132	60% gelatin	0.260			-1.46			No crater							
1073	22	214	80% gelatin	0.26			-1.46		0.25	1.20							
1074	22	215	80% gelatin	0.26			-1.46		0.33	0.62							
1075	22	176	Gelodyn 1	0.27			-1.48			No crater							
1076	23	73	Atlas 60	4.90			-3.87			0.62							
1077	22	194	80% gelatin	0.070			-0.94			Collar circle							
1078	22	195	80% gelatin	0.070			-0.94			Collar circle							
1079	22	77	60% gelatin	0.074			-0.96										
1080	22	204	80% gelatin	0.075			-0.96										
1081	22	205	80% gelatin	0.075			-0.96										
1082	22	206	80% gelatin	0.075			-0.96		1.17	1.82			3.66				
1083	22	248	60% gelatin	0.24			-1.42										
1084	22	153	60% gelatin	0.594			-1.92		3.25	3.34			19.75				
1085	23	98	Military C-3	1.00			-2.29		2.81	2.00			0.76				

Table 3 (Continued)

ITEM SOURCE NO.			SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS							
				EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG
1086	23	124	Coalite 7-S	1.98				-2.89		3.69	2.01			3.74			
1087	22	208	80% gelatin	0.082				-0.99		0.33	1.01			0.55			
1088	22	129	60% gelatin	0.146				-1.22									
1089	22	26	60% gelatin	0.044				-0.81		0.21	0.57			0.01			
1090	22	135	60% gelatin	0.406				-1.71									
1091	22	150	60% gelatin	0.406				-1.71		2.83	1.26			3.66			
1092	22	144	60% gelatin	0.147				-1.23		0.00	0.00						
1093	23	91	Military C-3	0.50				-1.86		2.18	1.77			1.70			
1094	22	138	60% gelatin	0.595				-1.95									
1095	23	79	Military C-3	4.85				-3.92		1.55	2.95			13.91			
1096	22	92	60% gelatin	0.074				-0.98			Crater						
1097	22	93	60% gelatin	0.074				-0.98			Crater						
1098	22	115	60% gelatin	0.070				-0.96			Camouflaged						
1099	23	70	Military C-3	1.99				-2.95		3.41	2.32			5.45			
1100	23	150	Coalite 7-S	20.11				-6.37††		7.27	7.75			241.62			
1101	22	192	80% gelatin	0.065				-0.94			Radial cracks						
1102	22	193	80% gelatin	0.065				-0.94			Radial cracks						
1103	23	26	Atlas 60	0.46				-1.81		1.21	0.88			0.48			
1104	22	65	60% gelatin	0.074				-0.99			No crater						
1105	23	52	Atlas 60	4.77				-3.97		3.36	1.68			1.70			
1106	22	212	80% gelatin	0.22				-1.42		0.12	0.36						
1107	22	247	60% gelatin	0.22				-1.42									
1108	22	250	60% gelatin	=0.22				-1.42									
1109	22	252	60% gelatin	0.22				-1.42									
1110	22	251	60% gelatin	=0.22				-1.43									
1111	22	99	60% gelatin	0.067				-0.98									
1112	22	116	60% gelatin	0.074				-1.01			No crater						
1113	22	98	60% gelatin	0.067				-0.99									

†† Shot fired in drift area.

Table 3 (Continued)

ITEM SOURCE SHOT			EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS							
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ_c	d _a FT	f _a FT	h _a FT	θ_a DEG	ϕ_a CU FT	d _i FT	α_i DEG	V _i CU FT
1114	22	63	Coalite 7-S	0.068			-0.99				No crater					
1115	22	265	60% gelatin	0.22			-1.45			0.32	No crater					
1116	22	266	60% gelatin	0.22			-1.45			0.82	No crater					
1117	22	267	60% gelatin	0.22			-1.45			0.95	No crater					
1118	22	213	80% gelatin	0.22			-1.46			0.30						
1119	23	34	Atlas 60	0.94			-2.38		2.72	4.39			31.70			
1120	23	44	Atlas 60	1.92			-3.01		3.31	4.99			30.19			
1121	22	232	80% gelatin	0.21			-1.44		1.71	0.80			0.75			
1122	22	54	Gelodyn 1	0.063			-0.98				No crater					
1123	22	126	60% gelatin	0.066			-0.98		1.21	1.22	Crater		2.25			
1124	22	141	60% gelatin	0.066			-0.98		0.33	0.75						
1125	22	216	80% gelatin	0.20			-1.42			7.53			400.0*			
1126	22	231	80% gelatin	7.66			-4.83				No crater					
1127	22	45	60% gelatin	0.059			-0.96		0.04	0.46			0.0			
1128	22	233	80% gelatin	0.21			-1.45		0.42	1.65			1.14			
1129	22	234	80% gelatin	0.21			-1.45				Crater 2 in. deep					
1130	22	190	80% gelatin	0.055			-0.94				Collar circle 1 in. deep					
1131	22	191	80% gelatin	0.055			-0.94		0.25	0.90			0.12			
1132	22	113	60% gelatin	0.063			-0.99		1.21	0.82			1.23			
1133	22	114	60% gelatin	0.066			-0.99				No crater					
1134	22	131	60% gelatin	0.194			-2.44				No crater					
1135	22	104	60% gelatin	0.359			-0.97				No crater					
1136	22	106	60% gelatin	0.059			-0.97				No crater					
1137	23	71	Military C-3	1.99			-3.15		3.26	4.36			0.48.99			
1138	22	105	60% gelatin	0.059			-0.98				No crater					
1139	22	229	80% gelatin	3.02			-3.62		4.58	4.55			88.50			
1140	22	146	60% gelatin	0.192			-1.46		2.67	1.75			3.41			
1141	22	217	80% gelatin	0.20			-1.46		0.25	0.54						

* Estimated.

Table 3 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS						TRUE		
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ_c	d _s FT	f _a FT	h _a FT	α_a DEG	V _a CU FT	d _t FT	r _t FT	α_t DEG	V _t CU FT
1142	22	218	80% gelatin	0.20			-1.46		0.33	0.96							
1143	22	219	80% gelatin	0.20			-1.46		0.08	0.30							
1144	22	221	80% gelatin	0.20			-1.46		0.83*	1.32*			5.80*				
1145	23	20	Atlas 60	1.92			-3.12		0.76	3.09			2.07				
1146	22	152	60% gelatin	0.450			-1.95		0.00	0.00							
1147	22	188	80% gelatin	0.090			-0.94		Collar circle 1 1/2 in. deep								
1148	22	189	80% gelatin	0.090			-0.94		Collar circle 1 1/2 in. deep								
1149	23	92	Military C-3	0.50			-2.01		2.45	0.86			1.02				
1150	23	99	Military C-3	1.00			-2.54		3.08	1.58			1.40				
1151	52	71	Pentolite	2.65			-3.5		2.1	4.7			25.0				
1152	52	72	Pentolite	2.65			-3.5		3.7	5.8			62.9				
1153	52	73	Pentolite	2.65			-3.5		3.5	4.1			33.6				
1154	52	74	Pentolite	2.65			-3.5		4.0	6.5			96.2				
1155	52	75	Pentolite	2.65			-3.5		3.8	4.9			47.7				
1156	52	76	Pentolite	2.65			-3.5		No crater								
1157	52	77	Pentolite	2.65			-3.5		No crater								
1158	52	78	Pentolite	2.65			-3.5		No crater								
1159	52	79	Pentolite	2.65			-3.5		No crater								
1160	52	80	Pentolite	2.65			-3.5		No crater								
1161	52	81	Pentolite	2.65			-3.5		No crater								
1162	52	82	Pentolite	2.65			-3.5		1.2	4.0			16.0				
1163	52	83	Pentolite	2.65			-3.5		No crater								
1164	52	84	Pentolite	2.65			-3.5		No crater								
1165	52	85	Pentolite	2.65			-3.5		No crater								
1166	52	111	Military C-3	2.65			-3.5		No crater								
1167	22	230	80% gelatin	5.28			-4.42						350.0*				
1168	22	220	80% gelatin	0.20			-1.48		0.25	0.76							
1169	22	149	60% gelatin	0.336			-1.71		2.83	1.10			2.94				

* Estimated.

(21 of 21 sheets)

[illegible]

Table 4
Results of Crater Measurements in Rock

EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS												
ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	CHARGE POSITION		APPARENT					TRUE				
							Z FT	λ _c	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT	
Shots Fired in Basalt																		
1215	46	14	TNT	25	25	2.92	0.0	0.0	0.73	2.02	0.17		1.57	3.06		21.9		
1216	46	15 (1A)	TNT	200	200	5.85	0.0	0.0	1.6	4.65			3.3	7.15		275		
1217	46	16 (2A)	TNT	200	200	5.85	0.0	0.0	1.2	5.3			2.6	7.15		201		
1218	46	17 (3A)	TNT	200	200	5.85	-1.2	-0.21	1.3	5.55			3.2	7.95		363.2		
1219	46	18 (4A)	TNT	200	200	5.85	-1.2	-0.21	1.1	3.7			4.0	7.5		379.4		
1220	46	13	TNT	25	25	2.92	-1.5	-0.51	3.05	4.59	0.29		3.39	6.02		164		
1221	46	2	TNT	75	75	4.22	-4.0	-0.95	0.70	3.49	0.39		5.20	9.92		972.0		
1222	46	9	TNT	25	25	2.92	-3.0	-1.03	1.20	2.38	0.27		4.90	5.30		125.6		
1223	46	3	TNT	75	75	4.22	-6.0	-1.42	3.43	6.92	0.41		7.50	13.78		1165		
1224	46	1	TNT	8	8	2	-3.0	-1.50	1.06	3.20	0.30		3.80	8.50		345.1		
1225	46	6	TNT	25	25	2.92	-4.5	-1.54	0.85	2.92	0.50		5.40	7.48		275.9		
1226	46	4	TNT	25	25	2.92	-6.0	-2.05	2.90	6.64	0.09		7.30	7.44		370.7		
1227	46	12	TNT	200	200	5.85	-12.0	-2.05	3.96	9.52	1.29		8.50	9.45	Not excavated	637.5		
1228	46	5	TNT	25	25	2.92	-7.5	-2.57	0.0	0.0	0.76							
1229	46	11	TNT	75	75	4.22	-12.5	-2.96	0.0	0.0	0.78			Not excavated				
1230	46	7	TNT	25	25	2.92	-9.0	-3.08	2.30	3.52	0.40		9.5	5.70		158		
1231	46	8	TNT	8	8	2	-7.0	-3.50	1.05	2.35	0.50		7.70	5.58		213		
1232	46	10	TNT	25	25	2.92	-10.5	-3.60	0.63	1.89	0.32		11.20	5.72		156		
Shots Fired in Chalk																		
1233	8		Ammonia gelatin	8.0			-0.8						2.5	5.4		96		
1234	8		Ammonia gelatin	8.0			-1.9						3.3	5.5		272		
1235	8		Semigelatin Type A	2.0			-1.4						1.3	3.4		18		
1236	8		Ammonia gelatin	8.0			-3.7						4.9	6.5		312		
1237	8		Semigelatin Type A	2.0			-2.5						2.7	4.2		70		
1238	8		Semigelatin Type A	8.0			-4.7						5.1	7.6		400		
1239	8		Semigelatin Type A	4.5			-4.7						5.0	6.6		261		
1240	8		Ammonia gelatin	8.0			-6.2						7.5	7.5		448		

* Numbers correspond to Bibliography numbers.

Table 4 (Continued)

*** Charge hole drilled horizontally.

Table 4. (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS															
			EXPLOSIVE TYPE	CHARGE WEIGHT LB.	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT				TRUE											
									d _a FT.	h _a FT.	α _a DEG	V _a CU FT.	d _i FT.	h _i FT.	α _i DEG	V _i CU FT.								
Slots Fired in Granite (Continued)																								
1267	8		Semigelatin Type A	6.2			-1.8								1.4	5.2		40.0						
1268	4	C-19	TNT	70.12	70.12	4.12	-4.12	-1.0							4.30	11.40		587.60						
1269	4	A-20	C-2	0.80			-0.98								0.75	2.46		4.85						
1270	4	C-16	TNT	14.12	14.12	2.42	-2.65	-1.09							2.20	4.16		40.08						
1271	4	A-9	C-2	0.50			-1.90								0.35	1.76		1.17						
1272	4	C-18	TNT	50.12	50.12	3.68	-4.08	-1.11							5.25	9.70		519.62						
1273	4	C-1	C-2	10.0			-2.40								3.00	5.80		107.10						
1274	4	B-22	C-2	250			-7.10								7.50	16.2		2,063.20						
1275	4	A-19	C-2	0.50			-0.90								0.45	1.92		1.75						
1276	4	C-20	C-2	100			-5.33								5.90	10.49		684.10						
1277	8		Semigelatin Type B	4.5			-2.0								0.9	3.5		11.0						
1278	4	A-7	TNT	1.62	1.62	1.17	-1.46	-1.24							1.30	2.50		8.66						
1279	4	A-4	C-2	2.20			-1.63								1.00	2.86		8.73						
1280	4	C-17	TNT	25.12	25.12	2.93	-3.66	-1.25							2.35	6.83		115.34						
1281	4	B-10	C-2	30.0			-3.75								3.50	9.24		323.93						
1282	4	A-12	C-2	18.0			-3.29								2.80	6.06		109.49						
1283	4	B-14-A	C-2	75.0			-5.38								3.02	10.32		320.97						
1284	4	A-21	C-2	0.51			-0.90								0.45	1.84		1.62						
1285	4	A-14	C-2	4.50			-2.18								1.55	3.49		21.48						
1286	4	B-21	C-2	215.0			-8.15								8.15	11.95		1,206.30						
1287	4	A-36	C-2	8.50			-2.80								2.70	6.61		125.97						
1288	4	A-41	TNT	10.13	10.13	2.16	-3.20	-1.47							1.45	4.50		31.30						
1289	4	C-8	TNT	40.12 ²	40.12	3.42	-5.06	-1.48							2.95	7.3		166.35						
1290	4	B-3	C-2	20.0			-4.04								3.05	5.35		93.93						
1291	4	C-7	C-2	45.0			-5.34								2.85	7.52		169.49						
1292	4	A-17	TNT	1.12	1.12	1.04	-1.60	-1.54							0.80	5.10		22.17						
1293	4	A-32-A	C-2	4.50			-2.59								2.25	6.19		96.01						

Table 4 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT.	λ _c	d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _i FT	f _i FT	α _i DEG	V _i CU FT
					Shots Fired in Granite (Continued)												
1294	4	A-35	C-2	7.00				-3.00						1.85	4.82		45.73
1295	4	A-18	C-2	0.20				-0.94						0.20	1.64		0.57
1296	4	A-10	TNT	1.12	1.12	1.04		-1.68	-1.62					0.50	1.73		1.60
1297	8		Semigelatin Type A	6.2				-3.0						1.1	5.8		33.0
1298	4	C-2	C-2	10.0				-3.55									
1299	4	B-13	C-2	60.0				-6.50						1.70	6.34		71.88
1300	4	C-9	TNT	25.12	25.12	5.93		-5.01	-1.71					4.00	8.63		313.48
1301	4	A-13	C-2	2.60				-2.42						3.65	6.71		173.16
1302	8		Semigelatin Type B	4.1				-2.8						0.50	1.02		0.55
1303	4	B-5	C-2	15.0				-4.39						1.1	5.8		38.1
1304	8		Gelatin Type B	1.2				-1.9						2.05	4.59		15.93
1305	8		Semigelatin Type B	1.2				-1.9						0.8	4.4		13.2
1306	8		Semigelatin Type B	19.0				-4.8						0.9	3.6		9.4
1307	8		Gelatin Type B	4.1				-2.9						1.6	6.2		64.6
1308	4	A-3	C-2	1.00				-1.83						1.2	4.3		20.1
1309	13	605	TNT	320	320	6.84		-12.5	-1.83					1.00	4.10		17.38
1310	8		Semigelatin Type B	9.6				-3.9						6.1	17.1		2,320
1311	8		Semigelatin Type B	32.0				-5.9						1.6	4.8		34.6
1312	8		Gelatin Type B	19.0				-5.1						2.0	9.0		125.0
1313	8		Gelatin Type B	9.6				-4.1						1.6	11.6		186.0
1314	4	A-37	C-2	5.00				-3.34						1.1	7.0		53.8
1315	4	A-11-A	C-2	1.50				-2.25						1.25	3.54		16.25
1316	8		Semigelatin Type B	4.3				-3.2						1.05	2.83		8.96
1317	4	B-16	C-2	39.0				-6.80						0.5	2.6		3.8
1318	4	A-29	TNT	3.23	3.13	1.46		-3.04	-2.08					3.55	8.40		263.44
1319	4	A-34-A	TNT	3.13	3.13	1.46		-3.04	-2.08					2.00	5.84		72.59
1320	4	C-3	C-2	10.0				-4.50						1.65	6.54		75.18
														2.50	6.27		103.55

Table 4 (Continued)

ITEM NO. SOURCE NUMBER			EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB.	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λc	d _a FT	l _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	l _t FT	α _t DEG	V _t CU FT
			Slots Fired in Granite (Continued)														
1321	4	A-6	TNT	0.62	5.13	1.72	-1.82	-2.13					0.95	2.77			7.78
1322	4	A-10	TNT	5.13	5.13	1.72	-3.79	-2.20					0.75	4.64			17.17
1323	8		Semigelatin Type A	6.2			-4.2						0.6	3.4			6.2
1324	4	A-38	C-2	3.75			-3.56						2.75	5.39			85.29
1325	4	A-33	C-2	3.00			-3.37						1.25	3.17			13.37
1326	4	B-2	TNT	7.12	7.12	1.92	-4.50	-2.34					1.20	1.63			3.40
1327	4	A-1	C-2	0.40			-1.75						0.25	0.60			0.09
1328	4	B-17	C-2	23.81			-6.80						2.90	7.74			182.76
1329	8		Semigelatin Type B	4.3			-5.5							No crater			
1330	4	B-19-A	C-2	20.0			-6.52						1.80	6.08			70.07
1331	13	612	TNT	320	320	6.84	-17.0	-2.49					7.6	13.2			2,090
1332	4	C-4	C-2	10.0			-5.52						1.25	3.77			18.70
1333	4	B-6	C-2	7.00			-4.96						1.70	4.60			38.39
1334	4	A-12	C-2	1.10			-2.69						0.10	0.17			0.00
1335	4	A-39	TNT	2.63	2.63	1.38	-3.73	-2.70					0.45	3.48			5.80
1336	8		Semigelatin Type B	4.3			-4.5							Just broke surface			
1337	4	A-5	C-2	0.30			-1.87						0.25	0.95			0.24
1338	4	C-13A	C-2	95.0			-12.90							Note caught fire			
1339	4	B-20	C-2	15.0			-7.08						1.60	6.74			76.38
1340	8		Semigelatin Type A	6.2			-5.3						0.5	2.3			2.7
1341	4	B-12	TNT	15.12	15.12	2.47	-7.17	-2.90					0.90	3.84			13.93
1342	4	A-30	C-2	2.00			-3.70						0.50	2.13			2.69
1343	4	C-5	C-2	10.0			-6.52						0.82	3.63			11.13
1344	4	B-8	C-2	5.30			-5.33						0.95	2.66			7.10
1345	4	B-18	C-2	11.38			-6.90						1.25	4.40			25.48
1346	4	B-4	C-2	4.00			-5.14						1.40	5.35			42.80
1347	4	C-12	C-2	70.0			-13.50						1.50	2.68			11.28

Table 4 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS										
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ_c	d_a FT	f_a FT	h_a FT	α_a DEG	V_a CU FT	d_t FT	f_t FT	α_t DEG	V_t CU FT		
						Shots Fired in Granite (Continued)													
1348	4	B-9		3.25			-4.90						1.40	5.45		43.76			
1349	4	A-16		0.46			-2.61								Slight surface cracking				
1350	4	A-32		1.12	1.12	1.04	-3.54	-3.41					0.25	0.20		0.01			
1351	4	C-10		10.0			-7.46								Broke weak surface joint				
1352	4	A-2		0.45			-1.85								No crater				
1353	4	C-6		10.0			-7.70								No crater				
1354	4	B-7		2.50			-4.95						0.80	2.77		6.53			
1355	13	606	320	320	6.84		-25.0	-3.65					2.0	5.20		857			
1356	4	B-14		7.50			-7.25						0.55	2.55		3.74			
1357	4	B-19		6.50			-6.94												
1358	4	A-11		0.45			-2.88								No crater				
1359	4	C-14		50.12	50.12	3.68	-13.79	-3.75					1.65	2.35		9.59			
1360	4	C-11		25.0			-11.29								No crater				
1361	4	A-31		1.00			-3.92						0.10	0.59		0.02			
1362	4	C-15		30.12	30.12	3.11	-12.38	-3.98							No crater				
1363	4	B-1		2.13	2.13	1.29	-5.20	-4.04					0.20	0.24		0.01			
1364	4	B-15		5.50			-7.20								No crater				
1365	4	B-11		4.63	4.63	1.67	-6.83	-4.10					0.35	2.33		2.02			
1366	4	C-13		40.00			-14.29								No crater				
1367	4	A-34		0.63	0.63	0.86	-3.82	-4.45							No crater				
1368	4	NC-1-C		26.20			-18.21						0.40	1.12		0.53			
							Shots Fired in Limestone												
1369	13	502	320	320	6.84		-2.5	-0.36					3.9	8.3		414			
1370	13	501	320	320	6.84		-6.6	-0.96					9.1	11.2		2,560			
							Shots Fired in Marlstone												
1371	8	Semigelatin Type A	3.4				-1.2						1.2	3.1		15.0			
1372	8	Semigelatin Type A	3.4				-2.4						2.6	3.3		32.0			

Table 4 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ_c	d_a FT	l_a FT	h_a FT	ϕ_a DEG	V_a CU FT	d_t FT	l_t FT	ϕ_t DEG	V_t CU FT
					Shots Fired in Marlstone (Continued)												
1373	8		Semigelatin Type A	13.5			-4.1							4.0	6.2		182.0
1374	8		Semigelatin Type A	7.6			-4.5							4.4	6.0		182.0
1375	8		Semigelatin Type A	3.4			-4.2							2.5	4.2		54.0
1376	8		Semigelatin Type A	3.4			-4.5							0.3	0.3		0.2
1377	8		Semigelatin Type A	3.4			-6.0							0.4	0.6		0.2
1378	8		Semigelatin Type A	1.5			-4.7								No crater		
					Shots Fired in Sandstone												
1379	48	16	TNT	25	25	2.92	0.0	0.0	0.95	3.44	0.08		19.2	1.09	3.82		31.3
1380	14	802	TNT	320	320	6.84	0.0	0.0						2.3	5.6		162
1381	8		Ammonia dynamite	8.0			-0.4							1.2	3.4		33
1382	8		Ammonia dynamite	8.0			-0.4							1.1	2.5		10
1383	8		Semigelatin Type A	8.0			-0.4							1.3	3.0		16
1384	8		Semigelatin Type A	8.0			-0.4							1.1	2.7		9
1385	8		Ammonia gelatin	8.0			-0.5							1.1	2.4		6
1386	4	D-2	C-2	2,560			-4.71							9.00	23.37		5,148
1387	4	D-1	C-2	1,080			-3.60							8.42	13.11		1,518
1388	14	801	TNT	320	320	6.84	-2.5	-0.36						4.8	11.6		810
1389	14	803	TNT	320	320	6.84	-2.5	-0.36						5.1	14.3		1,460
1390	14	807	TNT	320	320	6.84	-2.5	-0.36						5.8	13.1		1,020
1391	14	808	TNT	320	320	6.84	-2.5	-0.36						6.0	17.5		1,820
1392	14	818	TNT	320	320	6.84	-2.5	-0.36						6.5	15.6		1,440
1393	14	819	TNT	320	320	6.84	-2.5	-0.36						8.6	19.0		3,530
1394	14	809	TNT	1,080	1,080	10.26	-3.75	-0.36						9.7	32.6		8,650
1395	14	810	TNT	2,560	2,560	13.68	-5.0	-0.36						10.5	25.1		7,950
1396	14	811	TNT	2,560	2,560	13.68	-5.0	-0.36						11.0	23.3		6,880
1397	14	812	TNT	2,560	2,560	13.68	-5.0	-0.36						16.1	39.4		22,000
1398	14	813	TNT	10,000	10,000	21.54	-7.9	-0.36									

Table 4 (Continued)

ITEM NO.	SOURCE NUMBER	SHOT NUMBER	EXPLOSIVE DATA					CHARGE POSITION		CRATER DIMENSIONS						
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W 1/3 LB 1/3	Z FT	λc	APPARENT				TRUE			
									d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG
Shots Fired in Sandstone (Continued)																
1399	14	814	TNT	40,000	40,000	34.2	-12.5	-0.36					26.9	56.5		108,000
1400	14	815	TNT	40,000	40,000	34.2	-12.5	-0.36					26.9	70.5		125,000
1401	14	816	TNT	40,000	40,000	34.2	-12.5	-0.36					27.5	53.6		105,000
1402	14	817	TNT	320,000	320,000	68.4	-25.0	-0.36					47.0	94.8		512,000
1403	4	C-2	TNT	320	320	68.4	-2.96	-0.43					7.10	11.92		1,057
1404	8		Ammonia dynamite	8.0			-0.9						1.6	3.0		18
1405	8		Ammonia dynamite	8.0			-0.9						1.2	2.6		16
1406	8		Semigelatin Type A	8.0			-0.9						1.6	3.5		36
1407	8		Semigelatin Type A	8.0			-0.9						1.7	3.3		31
1408	8		Ammonia gelatin	8.0			-1.0						1.3	3.5		17
1409	48	11	TNT	8	8	2	-1.0	-0.5	1.28	3.46	0.07	24.8	1.75	4.99		73.2
1410	48	9	TNT	25	25	2.92	-1.5	-0.51	2.23	5.14	0.19	88.3	2.70	5.55		140
1411	47	1	TNT	25	25	2.92	-1.5	-0.51	2.20	6.00	0.56	127	3.88	6.75		237
1412	14	804	TNT	320	320	6.84	-5.0	-0.73					7.6	14.0		1,140
1413	4	B-14	TNT	104.00	104.00	4.70	-3.50	-0.74					5.65	11.54		788.37
1414	4	A-16	C-2	2.00			-1.04						0.82	2.46		5.19
1415	4	A-12	C-2	2.25			-1.12						1.10	3.58		14.78
1416	8		Gelatin Type A	8.0			-1.8						2.7	6.1		120
1417	8		Semigelatin Type A	8.0			-1.8						2.5	4.0		63
1418	4	C-1	TNT	70	70	4.12	-3.84	-0.93					5.91	8.85		485.15
1419	48	6	TNT	75	75	4.22	-4.0	-0.95	4.46	8.42	0.45	428.8	9.35	11.88		2,234
1420	48	14	TNT	25	25	2.92	-3.0	-1.03	1.30	4.92	0.20	145.6	4.69	6.48		342.4
1421	4	A-42	C-2	10.0			-2.38						1.60	4.80		38.61
1422	4	A-14	C-2	1.62			-1.34						1.40	2.57		9.71
1423	4	C-1	C-2	10.0			-2.50						2.48	5.11		58.38
1424	4	A-29	C-2	9.5			-2.50						1.98	3.99		33.00
1425	8		Semigelatin Type A	8.0			-2.4						3.0	5.8		1.30

Table 4 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W LB-TNT EQUIVALENT	Z FT	λc	APPARENT								
									d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	f _t FT	α _t DEG	V _t CU FT
Slots Fired in Sandstone (Continued)																	
1426	8		Semigelatin Type A	8.0			-2.4						3.5	5.5		100	
1427	4	A-17	C-2	4.25			-2.00						1.50	3.19		15.94	
1428	4	A-23	C-2	4.25			-2.00						2.15	4.64		48.58	
1429	8		Ammonis gelatin	8.0			-2.5						2.9	6.2		116	
1430	8		Gelatin Type A	8.0			-2.5						3.2	5.5		140	
1431	4	A-39	C-2	9.00			-2.70						2.50	4.87		62.16	
1432	4	A-4	C-2	1.50			-1.51						2.88	2.84		12.25	
1433	8		Gelatin Type A	8.0			-2.7						3.2	5.7		140	
1434	4	A-8	C-2	1.25			-1.48						1.10	2.85		9.38	
1435	8		Gelatin Type A	8.0			-2.9						3.3	5.4		130	
1436	8		Semigelatin Type A	8.0			-2.9						3.4	5.9		150	
1437	48	2	TNT	8	3	2	-3.0	-1.5	1.73	3.85	0.23	39.7	5.00	6.47		383.7	
1438	48	13	TNT	25	25	2.92	-4.5	-1.54	1.40	2.97	0.33	60.5	5.67	7.91		592.9	
1439	4	B-8	C-2	18.36			-4.14						3.80	10.11		407.07	
1440	4	A-36	C-2	6.00			-2.90						2.57	5.76		89.16	
1441	4	A-24	C-2	3.00			-2.32						1.40	5.04		37.26	
1442	4	C-2	C-2	10.0			-3.50						3.17	6.05		125.54	
1443	4	C-2A	C-2	10.0			-3.50						4.57	5.70		155.16	
1444	4	B-WX3	C-2	10.0			-3.50						2.32	5.15		64.41	
1445	4	A-37	TNT	4.62	4.62	1.67	-2.75	-1.65					1.90	4.00		31.79	
1446	4	A-34	C-2	6.00			-3.15						2.30	6.15		91.18	
1447	4	B-10	C-2	14.00			-4.30						3.45	8.92		226.50	
1448	4	A-35	TNT	4.12	4.12	1.60	-2.87	-1.79					2.32	4.05		39.00	
1449	14	805	TNT	320	320	5.84	-12.5	-1.82					14.9	9.2		1,190	
1450	4	B-19	TNT	38.12	38.12	3.36	-6.20	-1.84					5.40	6.41		232.06	
1451	8		Gelatin Type A	8.0			-3.9						0.7	6.0		100	
1452	8		Semigelatin Type A	8.0			-3.9						0.9	7.4		100	

Table 4 (Continued)

			EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT			TRUE					
									d _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	α _t DEG	V _t CU FT		
									Shots Fired in Sandstone (Continued)								
1453	4	B-5	TNT	8.38	8.38	2.03	-4.00	-1.97						2.80	9.27	251.81	
1454	4	C-6	C-2	21.0			-5.15							2.28	6.25	93.27	
1455	48	10	TNT	200	200	5.85	-11.6	-1.98	1.20	4.96	0.50	109	13.84	16.27	6,001.3		
1456	4	A-1	C-2	0.50			-1.58						0.38	0.84	0.28		
1457	48	12	TNT	25	25	2.92	-6.0	-2.05	1.38	4.64	0.27	78.3	7.40	10.55	1,487		
1458	4	A-48	TNT	6.62	6.62	1.88	-3.90	-2.07					2.25	3.04	21.81		
1459	4	C-3	C-2	10.0			-4.50						1.77	5.98	66.43		
1460	4	A-22	C-2	1.50			-2.41						1.20	3.22	13.02		
1461	4	A-20	C-2	1.56			-2.38						1.20	3.48	15.20		
1462	4	A-44	TNT	0.65	0.65	0.87	-1.84	-2.12					0.68	2.00	2.86		
1463	4	A-45	TNT	1.42	1.42	1.12	-2.46	-2.19					0.60	1.47	1.35		
1464	4	A-43	C-2	0.65			-1.92						0.35	1.39	0.73		
1465	4	A-40	TNT	2.75	2.75	1.40	-3.21	-2.29					1.00	3.26	11.13		
1466	4	C-9	TNT	12.12	12.12	2.30	-5.31	-2.31					1.85	5.97	69.11		
1467	8		Semigelatin Type A	8.0			-4.7						2.3	8.0	150		
1468	4	A-19	C-2	1.20			-2.50						1.05	2.38	6.22		
1469	4	A-30	C-2	3.28			-3.50						1.25	2.68	9.46		
1470	4	A-21	C-2	1.40			-2.66						0.90	2.62	6.50		
1471	4	A-32	C-2	3.00			-3.53						1.18	3.05	11.51		
1472	8		Gelatin Type A	8.0			-4.9						Just broke surface				
1473	4	A-47	C-2	6.50			-4.60						1.42	4.09	24.91		
1474	4	B-17	TNT	17.62	17.62	2.60	-6.42	-2.47					2.35	8.49	177.21		
1475	4	B-18	TNT	12.75	12.75	2.32	-5.75	-2.48					2.45	5.24	70.37		
1476	4	A-50	TNT	4.62	4.62	1.67	-4.15	-2.49					0.70	2.46	4.46		
1477	48	3	TNT	8	8	2	-5.0	-2.5	0.89	4.24	0.41	24.0	5.63	7.95	631.5		
1478	47	3	TNT	8	8	2	-5.0	-2.5	1.58	4.82	0.56	55.6	6.55	6.61	407.4		
1479	4	A-33	C-2	2.80			-3.55						1.03	3.22	11.18		

Table 4 (Continued)

ITEM NO.	SOURCE NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS									
		EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT				TRUE					
								d _a FT	f _a FT	h _a FT	α _a DEG	V _a CU FT	d _i FT	r _i FT	α _i DEG	V _i CU FT	
Shots Fired in Sandstone (Continued)																	
1480	4	C-2	0.38			-1.84							0.50	1.80		1.71	
1481	4	C-2	10.0			-5.50							1.90	4.82		46.28	
1482	48	TNT	25	25	2.92	-7.5	-2.57	0.40	1.07	0.43		9.45	9.15	11.54		2,327	
1483	4	C-2	6.00			-4.75							2.00	3.46		25.12	
1484	4	C-2	4.50			-4.85							0.68	1.12		0.89	
1485	48	TNT	75	75	4.22	-12.0	-2.84	1.00	0.54	1.26		0.81	12.80	16.34		5,905.7	
1486	4	C-7	8.12	8.12	2.01	-5.80	-2.88						0.80	1.88		2.98	
1487	4	C-13	70.00			-12.27							5.72	13.02		1,015.74	
1488	4	B-16	10.62	10.62	2.19	-6.62	-3.02						2.28	3.69		32.59	
1489	4	B-20	12.00			-6.91							2.20	5.23		63.00	
1490	4	C-5	10.0			-6.56								No crater			
1491	48	TNT	25	25	2.92	-9.0	-3.08	0.0	0.0	0.83		0.0	10.70	13.19		3,076.1	
1492	4	C-2	11.0			-6.85							0.65	2.04		2.84	
1493	8	Ammonia gelatin	8.0			-6.6							0.8	2.0		4	
1494	4	C-2	6.00			-6.17							0.80	2.01		3.37	
1495	8	Gelatin Type A	8.0			-6.8							Just broke surface				
1496	8	Semigelatin Type A	8.0			-6.8							Just broke surface				
1497	8	Gelatin Type A	8.0			-6.9							Just broke surface				
1498	8	Semigelatin Type A	8.0			-6.9							Just broke surface				
1499	48	TNT	8	8	2	-7.0	-3.5	0.0	0.0	0.23		0.0	8.60	3.12		35.4	
1500	4	B-15	6.75	6.75	1.89	-6.75	-3.57							No crater			
1501	48	TNT	25	25	2.92	-10.5	-3.60	0.0	0.0	0.37		0.0	11.98	9.52		1,209	
1502	14	TNT	320	320	6.84	-25.0	-3.64							No crater			
1503	4	C-11	33.62	33.62	3.23	-11.95	-3.70						3.75	2.61		5.34	
1504	4	C-14	35.0			-12.62							1.65	1.92		6.38	
1505	8	Semigelatin Type A	8.0			-9.8								No crater			
1506	8	Gelatin Type A	8.0			-9.9								No crater			

[illegible]

Table 5

Results of Crater Measurements in Ice

(1 of 4 sheets)

			EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS							
ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	APPARENT			TRUE				
									d _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	h _t FT	α _t DEG	V _t CU FT
1528	51	170	C-4	5.0			0.0		0.23	3.51			37.54			
1529	51	170R	C-4	5.0			0.0		0.23	3.06			36.05			
1530	51	110	Atlas 60	10.0			0.0		1.60	4.29			63.61			
1531	51	22	C-4	20.0			-0.03		2.28	5.67			155.29			
1532	51	108	Atlas 60	5.0			-0.21		1.90	4.08			49.59			
1533	51	170 1/4	C-4	5.0			-0.23		0.46	4.22			54.53			
1534	51	23	C-4	20.0			-0.38		2.63	6.84			261.86			
1535	51	17	C-4	10.0			-0.32		1.63	5.56			109.52			
1536	51	107	Atlas 60	10.0			-0.35		1.90	5.44			91.96			
1537	51	30	Coalite 5-S	2.5			-0.23		0.95	2.73			18.14			
1538	51	60	Coalite 5-S	5.0			-0.32		1.35	4.17			64.35			
1539	51	46	Coalite 5-S	10.0			-0.44		1.85	4.47			66.04			
1540	51	52	Coalite 5-S	20.0			-0.54		2.20	5.25			149.76			
1541	51	80	Coalite 7-S	20.0			-0.55		1.90	5.08			124.95			
1542	51	40	Coalite 5-S	5.0			-0.38		1.00	3.37			41.81			
1543	51	79	Atlas 60	5.0			-0.40		1.45	----			82.02			
1544	51	65	Coalite 7-S	10.0			-0.49		3.00	4.90			141.78			
1545	51	170 1/2	C-4	5.0			-0.46		0.68	4.06			47.07			
1546	51	106	Atlas 60	10.0			-0.62		2.65	5.70			202.93			
1547	51	61	Coalite 5-S	5.0			-0.51		1.81	4.15			63.65			
1548	51	16	C-4	10.0			-0.65		2.95	7.15			271.68			
1549	51	151	C-4	20.0			-0.83		4.93	7.24			339.09			
1550	51	47	Coalite 5-S	10.0			-0.72		2.05	4.92			80.26			
1551	51	53	Coalite 5-S	20.0			-0.93		2.20	7.21			203.42			
1552	51	31	Coalite 5-S	2.5			-0.48		1.00	2.56			11.74			
1553	51	81	Coalite 7-S	20.0			-1.01		2.56	6.31			193.31			
1554	51	38	Coalite 5-S	2.5			-0.54		1.00	3.45			20.04			
1555	51	66	Coalite 7-S	10.0			-0.92		4.02	5.74			3181.68			

* Numbers correspond to Bibliography numbers.

Table 5 (continued)

ITEM NO.			SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS							
				EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W 1/3 LB 1/3	Z FT	λc	da FT	ha FT	αa DEG	Va CU FT	dh FT	ht FT	αt DEG	Vt CU FT
1556	51	78	Atlas 60	5.0				-0.86		2.25	5.24		108.35				
1557	51	170 3/4	C-4	5.0				-0.92		1.15	4.70		81.81				
1558	51	113	Atlas 60	10.0				-1.20		2.15	5.45		143.34				
1559	51	152	C-4	20.0				-1.53		2.88	7.61		280.03				
1560	51	41	Coalite 5-S	5.0				-1.04		1.95	4.56		69.01				
1561	51	48	Coalite 5-S	10.0				-1.36		2.60	6.87		260.33				
1562	51	36	Coalite 5-S	2.5				-1.74		2.15	3.82		58.21				
1563	51	54	Coalite 5-S	20.0				-1.79		3.00	6.62		245.67				
1564	51	1	C-4	5.0				-1.20		2.0	4.97		114.15				
1565	51	10	C-4	10.0				-1.51		2.91	5.11		175.66				
1566	51	37	Coalite 5-S	2.5				-1.09		1.60	3.15		26.38				
1567	51	67	Coalite 7-S	10.0				-1.72		2.82	5.73		187.69				
1568	51	42	Coalite 5-S	5.0				-1.39		2.20	4.21		61.60				
1569	51	82	Coalite 7-S	20.0				-2.21		3.90	7.51		370.60				
1570	51	62	Coalite 5-S	5.0				-1.44		2.44	5.07		115.93				
1571	51	24	C-4	20.0				-2.37		3.92	8.51		470.66				
1572	51	32	Coalite 5-S	2.5				-1.27		1.55	3.31		30.11				
1573	51	171	C-4	5.0				-1.65		1.92	5.18		106.04				
1574	51	77	Atlas 60	5.0				-1.82		2.72	6.02		141.93				
1575	51	105	Atlas 60	10.0				-2.31		3.56	6.44		224.32				
1576	51	153	C-4	20.0				-2.94		4.74	7.52		396.19				
1577	51	25a	C-4	20.0				-2.92		4.62	9.67		517.05				
1578	51	2	C-4	5.0				-2.06		3.2	4.59		155.74				
1579	51	49	Coalite 5-S	10.0				-2.74		3.71	6.23		222.60				
1580	51	55	Coalite 5-S	20.0				-3.69		4.95	8.42		503.82				
1581	51	F. 3	Atlas 60	2.5				-1.89		2.13	4.98		76.96				
1582	51	63	Coalite 5-S	5.0				-2.48		3.48	5.81		213.93				
1583	51	11	C-4	10.0				-3.17		4.17	6.95		381.29				

Table 5 (Continued)

(3 of 4 sheets)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ_c	d _a FT	f _a FT	h _a FT	α_a DEG	V _a CU FT	d _h FT	f _h FT	α_h DEG	V _h CU FT
1584	51	258	C-4	20.0			-4.05		5.85	8.57			739.31				
1585	51	259	Atlas 60	20.0			-4.05		5.45	8.01			595.33				
1586	51	68	Coalite 5-S	10.0			-3.39		4.14	6.98			285.55				
1587	51	83	Coalite 7-S	20.0			-4.33		5.40	10.13			877.04				
1588	51	8	Atlas 60	2.5			-2.36		2.51	5.18			106.17				
1589	51	33	Coalite 5-S	2.5			-2.52		2.77	3.80			52.94				
1590	51	43	Coalite 5-S	5.0			-3.48		3.75	5.07			123.16				
1591	51	3	C-4	5.0			-3.73		4.93	5.00			157.96				
1592	51	76	Atlas 60	5.0			-3.80		4.70	6.57			276.96				
1593	51	26	C-4	20.0			-6.07		7.57	9.34			944.50				
1594	51	64	Coalite 5-S	5.0			-3.84		4.39	6.08			275.73				
1595	51	96-R	Atlas 60	20.0			-6.15		8.80	7.77			642.17				
1596	51	115	Atlas 60	10.0			-4.93		5.60	7.59			495.15				
1597	51	104	Atlas 60	40.0			-8.10		10.10	11.04			2181.70				
1598	51	12	C-4	10.0			-5.20		6.10	7.10			448.74				
1599	51	39	Coalite 5-S	2.5			-3.44		3.90	4.93			175.52				
1600	51	C	Atlas 60	2.5			-3.61		4.02	6.71			192.02				
1601	51	97	Atlas 60	20.0			-7.46		10.00	9.17			1180.15				
1602	51	120	Coalite 7-S	10.0			-6.00		7.13	10.07			1055.88				
1603	51	44	Coalite 5-S	5.0			-4.88		5.30	6.62			315.99				
1604	51	50	Coalite 5-S	10.0			-6.13		6.15	8.55			680.56				
1605	51	56	Coalite 5-S	20.0			-7.73		8.80	9.85			1144.02				
1606	51	84	Coalite 7-S	20.0			-7.80		8.90	9.89			1333.16				
1607	51	88	Coalite 7-S	2.5			-4.09		4.40	6.24			161.18				
1608	51	27	C-4	20.0			-8.18		9.66	9.26			1201.81				
1609	51	8	C-4	2.5			-4.20		4.85	5.90			240.95				
1610	51	6	C-4	5.0			-5.34		6.14	6.15			365.66				
1611	51	34	Coalite 5-S	2.5			-4.38		2.75	4.17			62.85				

Table 5 (Concluded)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	d _a FT	t _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	t _t FT	α _t DEG	V _t CU FT
1612	51	155	C-4	40.0			-11.07		11.90	12.55			1620.99				
1613	51	69	Coalite 5-S	10.0			-7.01		8.36	6.37			192.90				
1614	51	99	Atlas 60	20.0			-8.95		9.50	12.21			1682.38				
1615	51	4	C-4	5.0			-5.66			6.38							
1616	51	13	C-4	10.0			-7.23		9.65	7.15			538.76				
1617	51	13	C-4	20.0			-9.33			10.36							
1618	51	4	Atlas 60	2.5			-4.74		5.05	6.15			165.96				
1619	51	102	Atlas 60	40.0			-12.16		12.10	13.51			1874.83				
1620	51	116	Atlas 60	10.0			-7.65		8.70	8.95			917.63				
1621	51	90	Coalite 7-S	5.0			-4.89		5.20	6.67			338.37				
1622	51	D	Atlas 60	2.5			-4.94		5.13								
1623	51	100	Atlas 60	20.0			-10.10		11.20	9.76			1944.29				
1624	51	74	Atlas 60	5.0			-6.69		7.50	8.36			534.64				
1625	51	14	C-4	10.0			-8.59			6.96							
1626	51	45	Coalite 5-S	5.0			-6.90										
1627	51	35	Coalite 5-S	2.5			-5.74										
1628	51	7	C-4	2.5			-5.97										
1629	51	98	Atlas 60	20.0			-12.01		4.85	9.81							
1630	51	86	Coalite 7-S	10.0			-9.74		10.80								
1631	51	B	Atlas 60	2.5			-6.20		6.39				700.22				
1632	51	72	Atlas 60	10.0			-9.92			9.74							
1633	51	29	C-4	20.0			-12.98										
1634	51	5	C-4	5.0			-8.22										
1635	51	156	C-4	40.0			-16.95										
1636	51	G	Atlas 60	2.5			-6.80		7.10	9.28							
1637	51	101	Atlas 60	20.0			-14.47										
1638	51	103	Atlas 60	40.0			-18.67										
1639	51	H	Atlas 60	2.5			-7.58		7.66	2.92			144.76				

(4 of 4 sheets)

Table 6
Results of Crater Measurements in Snow

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION	CRATER DIMENSIONS									
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}		APPARENT						TRUE			
								Z FT	λ_c	d _a FT	r _a FT	h _a FT	α_a DEG	V _a CU FT	d _t FT	r _t FT	α_t DEG
1640	19	0-1	40% gelatin	0.452			0.00		1.00	1.96							
1641	19	01-5	TNT	0.50	0.50	0.794	0.00	0.00	1.42	3.00							
1642	19	02-5	TNT	0.50	0.50	0.794	0.00	0.00	1.75	2.67							
1643	19	0-2	40% gelatin	0.904			0.00		1.33	2.75							
1644	19	0-1	TNT	1.0	1.0	1.0	0.00	0.00	3.50	2.92							
1645	19	0-3	40% gelatin	1.356			0.00		1.75	2.67							
1646	19	0-15	TNT	1.5	1.5	1.145	0.00	0.00	1.92	2.79							
1647	19	0-4	40% gelatin	1.808			0.00		2.03	3.50							
1648	19	0-2	TNT	2.0	2.0	1.26	0.00	0.00	2.00	2.96							
1649	19	0-6	40% gelatin	2.712			0.00		1.92	3.29							
1650	38	1	TNT	8.0	8.0	2.0	-2.00	-1.00	3.60	5.80			166				
1651	38	2	TNT	8.0	8.0	2.0	-2.00	-1.00	3.50	6.70			224				
1652	38	3	TNT	8.0	8.0	2.0	-2.00	-1.00	3.40	5.50			185				
1653	19	20-6	40% gelatin	2.712			-1.67		2.83	4.46							
1654	19	20-4	40% gelatin	1.808			-1.67	-1.45	2.25	4.00							
1655	19	20-15	TNT	1.5	1.5	1.145	-1.67		2.33	4.16							
1656	19	20-3	40% gelatin	1.356			-1.67		2.25	4.25							
1657	19	25-21	TNT	2.0	2.0	1.26	-2.08	-1.65	2.08	3.96							
1658	19	25-22	TNT	2.0	2.0	1.26	-2.08	-1.65	2.08	3.96							
1659	19	20-2	40% gelatin	0.904			-1.67		1.83	3.66							
1660	19	21-1	TNT	1.0	1.0	1.0	-1.75	-1.75	1.75	3.25							
1661	19	25-11	TNT	1.0	1.0	1.0	-2.08	-2.08	1.83	2.96							
1662	19	25-12	TNT	1.0	1.0	1.0	-2.08	-2.08	1.92	3.29							
1663	19	25-13	TNT	1.0	1.0	1.0	-2.08	-2.08	2.00	3.12							
1664	19	20-05	TNT	0.5	0.5	0.794	-1.67	-2.10	1.17	2.83							
1665	19	20-1	40% gelatin	0.452			-1.67		1.08	2.92							
1666	19	40-6	40% gelatin	2.712			-3.33		1.58	4.50							
1667	19	40-4	40% gelatin	1.808			-3.33		1.50	3.58							

* Numbers correspond to Bibliography numbers.

Table 6 (Continued)

ITEM NO.		SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS							
				EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ_c	d _a FT	t _a FT	h _a FT	α_a DEG	V _a CU FT	t _t FT	α_t DEG	V _t CU FT
1668	19		40-3	40% gelatin	1.356			-3.33		1.25	3.16						
1669	19		41-15	TNT	1.5	1.5	1.145	-3.42	-2.98	1.67	3.21						
1670	19		46-2	TNT	2.0	2.0	1.26	-3.84	-3.04	1.33	3.29						
1671	19		40-1	TNT	1.0	1.0	1.0	-3.33	-3.33	1.25	2.54						
1672	19		32-5	TNT	0.5	0.5	0.794	-2.67	-3.36	1.92	2.5						
1673	19		40-2	40% gelatin	0.904			-3.33		0.83	2.67						
1674	19		33-5	TNT	0.5	0.5	0.794	-2.75	-3.46	0.92	2.79						
1675	19		60-6	40% gelatin	2.712			-5.00		1.00	3.62						
1676	19		60-4	40% gelatin	1.808			-5.00		1.00	2.79						
1677	19		62-2	TNT	2.0	2.0	1.26	-5.17	-4.10	1.25	2.46						
1678	19		40-1	40% gelatin	0.452			-3.33		0.92	1.71						
1679	19		60-15	TNT	1.5	1.5	1.145	-5.00	-4.36	1.50	1.79						
1680	19		42-5	TNT	0.5	0.5	0.794	-3.50	-4.41	0.83	2.38						
1681	19		60-3	40% gelatin	1.356			-5.00		0.92	3.00						
1682	19		78-6	40% gelatin	2.712			-6.50		1.25	2.66						
1683	19		57-1	TNT	1.0	1.0	1.0	-4.75	-4.75	1.33	2.00						
1684	19		58-1	TNT	1.0	1.0	1.0	-4.83	-4.83	1.50	1.50						
1685	19		70-15	TNT	1.5	1.5	1.145	-5.83	-5.10	4.58	1.75						
1686	19		60-2	40% gelatin	0.904			-5.00		2.00	1.5						
1687	19		63-1	TNT	1.0	1.0	1.0	-5.25	-5.25	0.67	0.67						
1688	19		81-2	TNT	2.0	2.0	1.26	-6.75	-5.36	2.83	1.21						
1689	19		80-4	40% gelatin	1.808			-6.67		0.92	2.17						
1690	19		75-1	TNT	1.0	1.0	1.0	-5.67	-5.67		0.62						
1691	19		80-15	TNT	1.5	1.5	1.145	-6.67	-5.82		1.16						
1692	19		70-1	TNT	1.0	1.0	1.0	-5.83	-5.83		0.62						
1693	19		90-2	TNT	2.0	2.0	1.26	-7.50	-5.95	3.00	0.96						
1694	19		80-3	40% gelatin	1.356			-6.67		0.17	0.50						
1695	19		57-5	TNT	0.5	0.5	0.794	-4.75	-5.98		0.50						

(See 3 sheets)

Table 6 (Concluded)

[illegible]

Table 7

Properties of Clays

	Area				
	Dugway, Utah, Wet Clay	Camp Cooke, California, Wet Clay	WES Clay Pad	WES Natural Clay	Panama Residual
Source	26	26	42	44	50
Depth range of samples, ft	1-4	2-12	0-8	1-6	0-12
Mechanical analysis, % finer than					
0.1 mm			98	99	
0.05 mm			94	95	
0.01 mm			25	32	
0.005 mm			13	22	
Classification					
	Medium to lean clay	Sandy or silty clay (CL)	Lean clay	Lean clay	Lean clay
Avg liquid limit	40	29	43	37	58.2
Avg plasticity index	19	10	20	13	8.3
Avg specific gravity	2.75	2.66			
Avg field dry weight, lb/cu ft	89.0	100	97	88	73
Avg field wet weight, lb/cu ft	116.6	124	117	106	110
Avg field moisture, %	31.5	24.3	20.8	20.1	43.4
Approximate water table depth, ft		5.5			
Avg angle of internal friction, deg	22			15	300
Avg seismic velocity, fps	5000			1120	3000

Dugway,
Utah,
Dry Clay

Table 8

Properties of Sands

	Area				
	Dugway, Utah, Wet Sand	Camp Cooke, California, Wet Sand	WES Interface Wet Sand	Yucca Flats Sand-Gravel	WES Interface Dry-to-Moist Sand
Source	26	26	41	26	41
Depth range of samples, ft	0-100	2-20	0-0.625	0-185	0-12.5
Mechanical analysis, % finer than					
No. 10		100		87	
No. 40		83		55	
No. 60	48	46		40	
No. 200	25	5		5	
Classification	Silty dune sand	Silty sand (SP-SM)	River sand	Sand-gravel mix	River sand
Avg plasticity index	NP	NP	NP	NP	NP
Avg specific gravity	2.67	2.64		2.56	
Avg field dry weight, lb/cu ft	97.9	82.2	97		96.5
Avg field wet weight, lb/cu ft	100.7	120	108.2	84.5	103
Avg field moisture, %	3	Above WT-22	11.8		6.6
Approximate water table depth, ft	150	2		1000	
Avg angle of internal friction, deg	32			49	
Avg field plate bearing, lb/sq ft				5000 at 2 ft	
Avg seismic velocity, fps	1500			3000	1250

Table 9

Properties of WES Loess and Silt, and Keweenaw Frozen Silt

	WES Test Site Loess	Area		Keweenaw Silt Blast Hole 184
		WES Silt Natural		
Source	39	44		22
Depth range of samples, ft	0-3	0-6		0-5
Mechanical analysis, % finer than				
0.1 mm	100	99		88
0.05 mm	96	93		24
0.01 mm	38	32		7
0.005 mm	22	21		
Classification	Loess	Sandy silt		Sandy silt
Avg liquid limit	41.8	34.75		
Avg plasticity index	20.5	9.5		NP
Avg specific gravity				2.63
Avg field dry weight, lb per cu ft	95	88.38		78.9
Avg field wet weight, lb per cu ft	113	114		106
Avg field moisture content, %	19.0	28.86		34.1
Avg angle of internal friction, deg		9.5		

Table 10

Properties of Chalk, Granite, Marlstone, and Sandstone

	Area				
	Niobrara Chalk	Lithonia Granite	Unaweep Granite	Green River Marlstone	Kanawha Sandstone
Source	8	8	13	8	8
Description	Chalky limestone	Gneissic	Fine to very coarse grained	Kerogenaceous, dolomitic lime-stone (oil shale)	Coarse grained
Apparent specific gravity	2.0	2.6	2.68	2.1	2.2
Tensile strength, psi		450	600		70
Compressive strength, psi	2,000	30,000	24,800	10,000	10,000
Tensile bearing strain, in./in.		280			500
Modulus of rupture, psi	300	2,000	2,510	400	400
Scleroscope hardness	10	85		45	30
Elastic constants (dynamic methods)					
Young's modulus, psi	0.75×10^6	3.0×10^6	4.37×10^6	1.2×10^6	1.0×10^6
Modulus of rigidity, psi	0.5×10^6	1.5×10^6	2.44×10^6	0.5×10^6	0.5×10^6
Longitudinal bar velocity, fps	5,000	9,000	10,800	6,000	5,000
Longitudinal field velocity, fps	7,500	18,500		13,000	5,000
Torsional velocity, fps			8,190		

APPENDIX A: ADDITIONAL CRATERING DATA

1. Since the completion of the draft of this report, additional cratering data have been received. These data are included herein and constitute, along with the main body of this report, all cratering data available at this time. The data presented in table A1 were extracted from two reports listed as references A1* and A2 in the "Source" column of table A1.

Properties of the Various Media Cratered

Suffield Experimental Station
(SES), Ralston, Alberta (reference A2)

2. Shots were fired at the SES in two areas, the Watching Hill Range and the Drowning Ford Flats Range. The surface conditions at these two sites are virtually identical. Approximately 80 per cent of all tested material was in the silt range, that is, finer than the No. 200 sieve.

"Samples from the topmost layers had moisture contents ranging from 2 to 3 percent to around 20 percent, and densities in the range 73-110 lb/cu. ft. The unconfined compressive strength was on the average about 10 tons/sq. ft. and the shear strength ranged from 0 up to a maximum of 14 tons/sq. ft. The percentage recovery after a compressive load of 1000 psi ranged from 5 percent to 18 percent." A2

3. When the position of the charge center of gravity was not given, it was computed from knowledge of the charge shape and weight, and by assuming a packing density of 90 lb per cu ft. Some of the charges used were various types of bombs. In computing the actual weight of explosive contained in a bomb, one-half of the total weight was assumed to be explosive.

Railroad Vulnerability
Program (reference A1)

4. The shots fired in the Railroad Vulnerability Program were detonated at Fort Eustis, Virginia. The soil consisted mainly of sandy silt except for the 378-lb charges which were fired in a soil consisting primarily of clay.

* Refer to corresponding numbers in list of references at end of appendix.

A2

"Soil samples were taken throughout the test area to determine soil properties relevant to the test objectives. The soil parameters measured included grain-size distribution, Atterberg limits (liquid and plastic), cohesive strength and angle of internal friction, density, and moisture content.

"Most of the soil encountered was classified as sand or sandy silt. In general, the soils with the higher percentages of clay were found near the surface. Both the strength tests and the Atterberg indices indicated cohesive strengths ranging from 0 psi in the sands to 20 psi in the soils with higher clay contents."A1

References

- A1. Case Institute of Technology, Railroad Vulnerability Program (SECRET). Technical Memorandum No. 21, University Circle, Cleveland, Ohio, August 1958.
- A2. Jones, G. H. S., Spackman, N., and Winfield, F. H., Cratering by Ground Burst TNT at Suffield Experimental Station, Ralston, Alberta (UNCLASSIFIED). Suffield Technical Paper No. 158, August 1959.

Table A-
Results of Crater Measurements in Soil

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS							
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W ₀ LB-TNT EQUIVALENT	W _{1/3} LB ^{1/3}	Z FT	λ _c	APPEARANT			TRUE				
									d ₁ FT	d ₂ FT	α ₁ DEG	V ₁ CU FT	d ₁ FT	d ₂ FT	α ₁ DEG	V ₁ CU FT
Spots Fired in Silt																
1711	A2	1	TNT	8	8	2	+0.28	+0.14	3.7	0.8						
1711	A2	2	TNT	8	8	2	+0.28	+0.14	3.7	0.8						
1712	A2	3	TNT	8	8	2	+0.28	+0.14	0.7	0.8						
1713	A2	4	TNT	8	8	2	+0.28	+0.14	0.8	0.8						
1714	A2	5	TNT	8	8	2	+0.28	+0.14	0.7	0.8						
1715	A2	6	TNT	8	8	2	+0.28	+0.14	0.7	0.8						
1716	A2	7	TNT	8	8	2	+0.28	+0.14	0.6	0.8						
1717	A2	8	TNT	8	8	2	+0.28	+0.14	0.3	0.8						
1718	A2	9	TNT	8	8	2	+0.28	+0.14	0.5	0.8						
1719	A2	10	TNT	8	8	2	+0.28	+0.14	0.5	0.7						
1720	A2	11	TNT	60	60	3.9	+0.54	+0.14	1.4	2.4						
1721	A2	12	TNT	60	60	3.9	+0.54	+0.14	1.5	2.3						
1722	A2	13	TNT	60	60	3.9	+0.54	+0.14	1.4	2.4						
1723	A2	14	TNT	60	60	3.9	+0.54	+0.14	1.6	2.2						
1724	A2	15	TNT	60	60	3.9	+0.54	+0.14	1.6	2.4						
1725	A2	16	TNT	60	60	3.9	+0.54	+0.14	1.3	2.0						
1726	A2	17	TNT	60	60	3.9	+0.54	+0.14	1.5	1.9						
1727	A2	18	TNT	60	60	3.9	+0.54	+0.14	1.8	1.8						
1728	A2	19	TNT	60	60	3.9	+0.54	+0.14	1.7	1.9						
1729	A2	20	TNT	60	60	3.9	+0.54	+0.14	1.5	1.9						
1730	A2	21	TNT	60	60	3.9	+0.54	+0.14	1.7	2.0						
1731	A2	22	TNT	60	60	3.9	+0.54	+0.14	1.9	1.9						
1732	A2	23	TNT	60	60	3.9	+0.54	+0.14	No data obtained							
1733	A2	24	TNT	60	60	3.9	+0.54	+0.14	1.5	2.0						
1734	A2	25	TNT	60	60	3.9	+0.54	+0.14	1.9	3.5						
1735	A2	26	TNT	60	60	3.9	+0.54	+0.14	1.7	6.0						
1736	A2	27	TNT	60	60	3.9	+0.54	+0.14	1.8	2.1						
1737	A2	28	TNT	60	60	3.9	+0.54	+0.14	1.8	2.1						

* Numbers correspond to Appendix A reference numbers.

** Shot detonated on surface or deeply frozen ground.

Table A1 (Continued)

ITEM SOURCE NO.	SHOT NUMBER	EXPLOSIVE DATA				CHARGE POSITION		CRATER DIMENSIONS					
		EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ_c	d _a FT	t _a FT	h _a FT	α_a DEG	V _a CU FT	TRUE t _t FT α_t DEG V _t CU FT
						Shots Fired in Silt (Continued)							
1737	A2	TNT	30	30	3.1	+0.23	+0.07	2.2	1.6				
1738	A2	TNT	30	30	3.1	+0.23	+0.07	2.0	2.0				
1739	A2	TNT	30	30	3.1	+0.23	+0.07	2.7	1.6				
1740	A2	TNT	30	30	3.1	+0.23	+0.07	2.2	1.6				
1741	A2	TNT	33	30	3.1	+0.23	+0.07	2.2	1.5				
1742	A2	TNT	30	30	3.1	+0.23	+0.07	2.3	1.6				
1743	A2	TNT	30	30	3.1	+0.23	+0.07	3.0	1.5				
1744	A2	TNT	30	30	3.1	+0.23	+0.07	2.2	1.6				
1745	A2	TNT	30	30	3.1	+0.23	+0.07	2.6	1.6				
1746	A2	TNT	520	520	8.05	+0.59	+0.07	3.43	6.2	0.2			
1747	A2	TNT	512	512	8.0	+0.59	+0.07	4.8	6.2	1.1			
1748	A2	TNT	521	521	8.05	+0.59	+0.07	3.26	5.8	0.4			
1749	A2	TNT	523	523	8.05	+0.59	+0.07	3.0	5.8	0.3			
1750	A2	TNT	552	551	8.20	+0.60	+0.07	3.8	6.1	0.5			
1751	A2	TNT	600	600	8.43	+0.62	+0.07	3.7	6.6	0.5			
1752	A2	TNT	8	8	2	+0.12	+0.06	1.5	1.0				
1753	A2	TNT	8	8	2	+0.12	+0.06	1.6	1.0				
1754	A2	TNT	8	8	2	+0.12	+0.06	1.7	0.9				
1755	A2	TNT	8	8	2	+0.12	+0.06	1.5	0.9				
1756	A2	TNT	8	8	2	+0.12	+0.06	1.6	0.9				
1757	A2	TNT	8	8	2	+0.12	+0.06	1.2	0.7				
1758	A2	TNT	8	8	2	+0.12	+0.06	1.3	0.6				
1759	A2	TNT	8	8	2	+0.12	+0.06	1.4	0.7				
1760	A2	TNT	8	8	2	+0.12	+0.06	1.6	0.8				
1761	A2	TNT	8	8	2	+0.12	+0.06	1.5	0.8				
1762	A2	TNT	8	8	2	0	0	0.9	1.1				
1763	A2	TNT	8	8	2	0	0	0.6	1.2				

Table A1 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA			CHARGE POSITION		CRATER DIMENSIONS								
			EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	λ _c	d _s FT	h _s FT	α _s DEG	V _s CU FT	d _t FT	α _t DEG	V _t CU FT	
							Shots Fired in Silt (Continued)									
1764	A2	13	TNT	8	8	2	0	0	0.8	1.1						
1765	A2	14	TNT	8	8	2	0	0	0.7	1.2						
1766	A2	15	TNT	8	8	2	0	0	0.9	1.2						
1767	A2	16	TNT	8	8	2	0	0	1.1	1.2						
1768	A2	17	TNT	8	8	2	0	0	0.9	1.2						
1769	A2	18	TNT	8	8	2	0	0	1.0	1.0						
1770	A2	19	TNT	8	8	2	0	0	1.3	1.4						
1771	A2	20	TNT	8	8	2	0	0	1.0	1.0						
1772	A2	51	TNT	60	60	3.9	0	0	2.0	2.2	0.25					
1773	A2	52	TNT	60	60	3.9	0	0	2.3	2.3	0.25					
1774	A2	53	TNT	60	60	3.9	0	0	2.1	2.4	0.20					
1775	A2	54	TNT	60	60	3.9	0	0	2.4	2.3	0.20					
1776	A2	55	TNT	60	60	3.9	0	0	2.4	2.8	0.30					
1777	A2	56	TNT	60	60	3.9	0	0	2.2	2.9	0.38					
1778	A2	57	TNT	60	60	3.9	0	0	2.4	3.1	0.30					
1779	A2	58	TNT	60	60	3.9	0	0	1.8	2.4	0.30					
1780	A2	59	TNT	60	60	3.9	0	0	2.0	2.4						
1781	A2	60	TNT	60	60	3.9	0	0								
							Shots Fired in Sandy Silt									
1782	A1	40	TNT	270	6.46	-5.5	-0.85	6.0	17.4							
1783	A1	52	TNT	540	8.15	-7.0	-0.86	9.2	20.4							
1784	A1	61	TNT	540	8.15	-8.0	-0.98	9.1	21.4							
1785	A1	57	TNT	540	8.15	-8.3	-1.02	9.3	19.4							
1786	A1	41	TNT	270	6.46	-7.8	-1.20	6.9	16.9							
1787	A1	53	TNT	54	3.78	-4.7	-1.24	6.0	11.0							
1788	A1	54	TNT	54	3.78	-4.7	-1.24	6.3	11.3							
1789	A1	55	TNT	54	3.78	-4.7	-1.24	5.7	11.0							

Dimension affected by boundary condition not included in calculation of crater radius.

Table A1 (Continued)

Table A1 (Continued)

ITEM NO.	SOURCE	SHOT NUMBER	EXPLOSIVE DATA	CHARGE POSITION	CRATER DIMENSIONS								
EXPLOSIVE TYPE	CHARGE WEIGHT LB	W LB-TNT EQUIVALENT	W ^{1/3} LB ^{1/3}	Z FT	A _c	APPARENT		TRUE					
						d _a FT	h _a FT	α _a DEG	V _a CU FT	d _t FT	h _t FT	α _t DEG	V _t CU FT
Shots Fired in Sandy Silt (Continued)													
1790	AI	56	TNT	54	5	3.78	-4.7	-1.24	4.4	8.0			
1791	AI	44†	TNT	270	27	6.46	-8.0	-1.24	6.2	12.7			
1792	AI	49	TNT	270	27	6.46	-8.0	-1.24	7.0	15.8			
1793	AI	39†	TNT	31	31	4.33	-5.4	-1.25	6.5	14.7			
1794	AI	47	TNT	31	31	4.33	-5.4	-1.25	6.2	12.2			
1795	AI	63†	TNT	31	31	4.33	-5.4	-1.25	7.0	11.8			
1796	AI	46†	TNT	270	27	6.46	-8.9	-1.36	7.8	15.9			
Shots Fired in Clay													
1797	AI	59	TNT	378	378	7.23	-4.5	-0.62	9.3	20.0			
1798	AI	58†	TNT	378	378	7.23	-8.4	-1.16	8.8	21.2			
1799	AI	62†	TNT	378	378	7.23	-6.5	-1.18	11.1	20.5			
1800	AI	60†	TNT	378	378	7.23	-8.7	-1.20	7.8	18.9			
1801	AI	50†	TNT	378	378	7.23	-9.4	-1.24	9.0	18.2			

† Dimension affected by boundary condition not included in calculation of crater radius.

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